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

II B.Tech II Semester Supplimentary Examinations, Aug/Sep 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. (a) A vertical cylinder of diameter 180mm rotates concentrically inside another cylinder of diameter 181.2mm. Both the cylinders are 300mm high. The space between the cylinders is filled with a liquid whose viscosity is unknown. Determine the viscosity of the fluid if a torque of 20Nm is required to rotate the inner cylinder at 120r.p.m
   (b) What are differential manometer? [10+6]

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 are the different energies of a fluid? Explain each of them.
   (b) Water is flowing through a pipe having diameter 300mm and 200mm at the bottom and upper end respectively. The intensity of pressure at the bottom end is 24.525 N/c m^2 and pressure at the upper end is 9.81 N/c m^2. Determine the difference in datum head, if the rate of flow through pipe is 40 Lit /s. [6+10]

4. (a) Derive an expression for discharge as liquids through a rectangular notch.
   (b) A 120mm $\times$ 60mm venturimeter with $C_d = 0.98$ is to be replaced by an orifice meter having a value of $C_d = 0.6$, is both the meters are to give the same differential mercury monometer reading for a discharge of 100 lit/sec and the inlet diameter to remain 125 mm. what should be the diameter of orifice.[7+9]

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) What do you mean by 'pipes in series' and 'pipes in parallel'? How the loss of head is to be determined?

   (b) A pipeline 0.25 m in diameter and 1600 m long has a slope of 1 in 200 for the first 800 m and 1 in 100 for the next 800m. The pressure at upper end of the pipeline is 120 kN/m^2 and at the lower end is 60 kN/m^2. Taking 4f = 0.04, determine discharge through the pipe. [8+8]

7. Two reservoirs are connected by a pipeline of diameter 600 mm and length 4000M. The difference of water level in the reservoirs is 20 M. At a distance of 1000M from the upper reservoir, a small pipe is connected to the pipeline. The water can be taken from the small pipe. Find the discharge to the lower reservoir, if

   (a) No water is taken from the small pipe, and

   (b) 100 lit/s of water is taken from small pipe. Take f=0.005 and neglect minor losses. [16]

8. (a) Explain briefly about stagnation point?

   (b) Avessel fitted with a nozzle, contains air at pressure of 2500KN/m^2 and a temperature of 20^0C.If the pressure at the outlet of the nozzle is 1750 KN/m^2 find the velocity of air flowing at the outlet of the nozzle. Take K=1.4 and R=287 J/Kg K. [8+8]

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Code No: R05220302 **Set No. 2**

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

Answer any FIVE Questions
All Questions carry equal marks

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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 an incompressible fluid the velocity components are $u = x^3 - y^3 - z^2x, v = y^3 - z^3, w = -3x^2z - 3y^2z + \frac{z^3}{3}$. Determine whether the continuity equation is satisfied.
   (b) Distinguish between pathlines, stream lines and streaklines. [8+8]

3. An open circuit wind tunnel draws air from the atmosphere through a well contoured nozzle. In the test section, where the flow is straight and nearly uniform, a static pressure tap is drilled into the tunnel wall. A manometer connected to the tap shows that the wall pressure within the tunnel is 45 mm of water below atmospheric. Assume that air is incompressible and at 25^0 C, pressure is 100 Kpa(absolute). Calculate the velocity in the wind tunnel section. Density of water is 999kg/m^3 and characteristic gas constant for air is 287 J/Kg K. [16]

4. (a) Define and explain Reynolds number, Froude Number and Mach number.
   (b) For measuring the flow of oil of specific gravity 0.81 in a pipeline inclined to 45^0 to the horizontal, a venturimeter is used. The throat area ratio is 4. If the difference in a mercury levels in the gauge is 45mm, Calculate the flow if the pipe diameter is 30m. Take Cd =0.97 and Specific gravity of mercury as 13.6. [6+10]

5. (a) What do you mean by coefficient of drag and coefficient of lift? What are the factors that influence these coefficients?
   (b) An airplane weighing 30000 N has a wing area of $25m^2$. It flies at a velocity of 1000 km per hour at a steady level in still air. The engine develops 9.5 $\times 10^6$ watts of power and has a mechanical efficiency of 65%. Determine the lift and drag coefficients for the wind. Take density for air = 1.25 kg/m^3. [8+8]

6. Two reservoirs are connected by three cast iron pipes in series. The length and diameter of the pipes are L_1 = 600 m, D_1 = 0.3 m, L_2 = 900 m, D_2 = 0.4 m, L_3 = 1500 m and D_3 = 0.45 m respectively. Find out Reynolds number in each

of the pipes. The density and viscosity of water are 1000 kg/m^3 and 1.1 $\times 10^{-3}$ N-sec/m^2. The friction factor in each pipe may be approximated as 0.02. The loss due expansion at the junctions between pipe-1 and pipe-2 as well as between pipe-2 and pipe-3 may be neglected. The discharge is 0.11 m^3/sec. Determine the difference in elevation between the top surfaces of reservoirs. Include the entry loss to pipe-1 and exit loss between pipe-3 and adjacent reservoir. [16]

7. (a) Sketch the Reynolds apparatus and explain how the laminar flow can be demonstrated with the help of this apparatus?

   (b) Oil of absolute viscosity 1.5 poise and relative density 0.85 flows through a 30cm diameter pipe .If the head losses in a 3000M length of a pipe is 20M.estimate the friction factor by assuming the flow to be laminar. [8+8]

8. (a) Explain briefly about stagnation point?

   (b) Avessel fitted with a nozzle, contains air at pressure of 2500KN/m^2 and a temperature of 20^0C.If the pressure at the outlet of the nozzle is 1750 KN/m^2 find the velocity of air flowing at the outlet of the nozzle. Take K=1.4 and R=287 J/Kg K. [8+8]

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Code No: R05220302 **Set No. 3**

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1. (a) Explain with sketches how ships will be unstable when the meta-centric height is negative.
   (b) What is capillarity? Derive expression for height of capillary rise [8+8]

2. (a) What is the irrotational velocity field associated with the potential $\phi = 3x^2 - 3x + 3y^2 + 16t^2 + 12zt$. Does the flow field satisfy the incompressible continuity equation?
   (b) Show that the streamlines and equipotential lines formla net of mutually perpendicular lines. [8+8]

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. Explain Venturimeter principle with neat sketch and also derive and expression for finding out actual discharge from a given venturimeter. [16]

5. (a) What type of drag predominates in the following cases.
      i. Thin plates placed parallel to flow direction
      ii. Disks and plates placed perpendicular to flow direction
      iii. Cylinder with axis perpendicular to flow direction
      iv. Well-streamlined bodies.
   (b) Why is it that the drag force on a flat plate held at right angles to the direction of flow is greater than the drag force on the same plate held parallel to the direction of flow?
   (c) A paratrooper descends in air of density 1.25 kg/m^3 with the help of a parachute which is hemispherical having a diameter of 4.5 m. If the weight of the paratrooper and parachute is 785 N, find the terminal velocity attained. Take coefficient of drag as 0.5. [4+6+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) 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) Write short notes on:
      i. Mach angle,
      ii. Zone of Action,
      iii. Zone of silence.
   (b) Define Mach number and explain sonic flow, subsonic flow and super - sonic flow
   (c) An Aeroplane is flying at an height of 15 Km where the temperature is - 50^0 C. The speed of the plane is corresponding to M=2. Assume K = 1.4and R = 287 J/Kg. K, find the speed of the plane. [5+5+6]

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Code No: R05220302 **Set No. 4**

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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) For an incompressible fluid the velocity components are $u = x^3 - y^3 - z^2x, v = y^3 - z^3, w = -3x^2z - 3y^2z + \frac{z^3}{3}$. Determine whether the continuity equation is satisfied.
   (b) Distinguish between pathlines, stream lines and streaklines. [8+8]

3. An open circuit wind tunnel draws air from the atmosphere through a well contoured nozzle. In the test section, where the flow is straight and nearly uniform, a static pressure tap is drilled into the tunnel wall. A manometer connected to the tap shows that the wall pressure within the tunnel is 45 mm of water below atmospheric. Assume that air is incompressible and at 25^0 C, pressure is 100 Kpa(absolute). Calculate the velocity in the wind tunnel section. Density of water is 999kg/m^3 and characteristic gas constant for air is 287 J/Kg K. [16]

4. (a) Explain Reynolds's model law.
   (b) An orifice meter is to be fitted into a horizontal pipe of 25 cm diameter, carrying oil of specific gravity 0.86 for the purpose of flow measurement. The differential head is to be indicated by a U-tube Manometer containing mercury of specific gravity 13.6. If the manometer reading is not to exceed 0.2 m when the flow is 15 kg/sec. What would the diameter of the orifice? Take Cd=0.621. [6+10]

5. (a) Distinguish between deformation drag, surface drag and form drag. In case of sphere, discuss their relative importance at various increasing values of Reynolds number.
   (b) Calculate the diameter of the parachute to be used for dropping an object weighing 1000 N so that the maximum terminal velocity of dropping is 5 m/sec. The drag coefficient for parachute which may be treated as hemispherical is 1.3 and the value of density of air is 1.216 kg/m^3. [10+6]

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) What do you understand by turbulent flow? What factors decides the type of flow in pipes?

   (b) Water is flowing through a rough pipe of diameter 40cm and length 3000m at the rate of 0.4 m^3/s. Find the power required to maintain this flow. Take the average height of roughness of K = 0.3mm. [6+10]

8. (a) what is the relation between pressure and density of a compressible fluid for?

      i. Isothermal process

      ii. Adiabatic process.

   (b) A gas is flowing through a horizontal pipe at a temperature of 4^0C. The diameter of the pipe is 8cm and at a section I in the pipe, the pressure is 30.3N/cm^2 (gauge). The diameter of the pipe changes from 8cm to 4cm at the section II, where pressure is 20.3N/cm^2 (gauge). Find the velocities of the gas at these sections assuming an isothermal process. Take R=287.14Nm/Kg.K and atmosphere pressure=10N/ cm^2. [6+10]

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