II B.Tech II Semester Regular Examinations, Apr/May 2006
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) State Newton's law of viscosity. Distinguish between Newtonian and Non-Newtonian fluids.
   (b) A circular disc of diameter d is slowly rotated in a liquid of large viscosity μ at a small distance h from a fixed surface. Draw the sketch and derive an expression for the torque T necessary to maintain an angular velocity ω . [8+8]

2. (a) Define and distinguish laminar and turbulent flows. Give two real fluid flow examples of each. How are they distinguished in real fluid flow?
   (b) For steady, incompressible flow, verify whether the following values of u and v are possible:
      i. u = 4 x y $+y^2$, v = 6xy + 3x
      ii. u = 2 x^2+y^2, v =- 4xy and
      iii. $\frac{-x}{(x^2+y^2)}$, $\nu = \frac{-y}{(x^2+y^2)}$ [8+8]

3. (a) Derive Euler's equation of motion for a fluid flow..
   (b) A jet of water issues from 20 mm dia fire hose at the end of which a 5.0 mm diameter nozzle is fixed. If pressure at inlet of the nozzle is 200 kN/m^2, determine force exerted by nozzle on the flow. [8+8]

4. (a) What is the physical significance of displacement thickness of boundary layer theory?
   (b) What boundary conditions must be satisfied by the velocity distribution in laminar boundary layer over a flat plate.
   (c) The velocity distribution in the boundary layer was found to fit the equation $(u/U) = (y/d)^{1/7}$. Find the displacement thickness. [4+4+8]

5. (a) Differentiate between compressible and incompressible flows.
   (b) A large vessel fitted with a nozzle ,contains air at pressure of 2500 KN/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? [8+8]

6. (a) Derive Hazen-poisehille equation for laminar flow in circular pipes.
   (b) Explain in detail how the flow is demonstrated using Reynold's experiment.

[8+8]

7. (a) What is meant by the terms piezometric head and friction slope. Is it always necessary that HGL be above the pipe axis. Can it not intersect the pipe axis or lie below the pipe axis.

   (b) A pipe line AB of diameter 30cm and length 40m carries water at the rate of 50lit/sec. The flow takes place from A to B where point B is 30m above A. Find the pressure at A if the pressure at B is $19.62 N/cm^2$. Take f=0.008[8+8]

8. (a) A venturimeter has its axis vertical, the inlet and throat diameters being 150 mm and 75 mm respectively. The throat is 225 mm above inlet and k = 0.96, petrol of specific gravity 0.78 flows up through the meter at a rate of 0.029 m^3/s. Find the pressure difference between the inlet and the throat.

   (b) Explain the working procedure of Bourdon pressure gauge. [8+8]

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   [8+8]

2. (a) Define stream function and explain its characteristics.
   (b) If for a two dimensional potential flow, the velocity potential is given by $\phi = X(2Y - 1)$
   Determine the velocity at the point P(4,5).
   Determine also the value of stream function ψ at the point P. [8+8]

3. (a) Derive an expression for Bernoulli's equations for flow along a stream line.
   (b) A U - tube contains a liquid of relative density 1.25 to a height of 25 cm in both the columns. It is rotated about a symmetrical vertical axis which is 15 cm from both the limbs. Calculate the pressures at the bottom horizontal connecting points and mid point when the speed of rotation is 240 rpm.[8+8]

4. (a) Define the following terms for an air foil. (i) Camber (ii) Angle of attack (iii) Profile centerline (iv) Aspect ratio
   (b) Calculate the diameter of a parachute to be used for dropping a body weighing 1000 N so that the maximum terminal velocity of dropping is 5 m/s. The drag coefficient for parachute which may be treated as hemispheroid is 1.3 and the value of the mass density of the air is 1.2 kg $/m^3$.
   (c) How does the drag coefficient change with (i) surface roughness (ii) turbulence level [6+6+4]

5. Find the mass flow rate of air through Venturimeter having inlet diameter 300 mm and throat diameter 150 mm , The pressure and temperature of air at inlet section of venture meter are$137KN/m^2 and 15^0$ C respectively and pressure at throat is $127KN/m^2$. Take$R = 290J/Kg^0K$ and adiabatic expansion$\gamma = 1.4$. [8+8]

6. (a) Derive an expression for mean velocity of flow for laminar flow through inclined pipes.

(b) Derive the necessary condition for mean velocity for the laminar flow between parallel flat plates when both the plates are at rest. [8+8]

7. (a) Sketch and explain the hydraulic gradient and total energy line for an inclined pipe and horizontal pipe discharging freely in atmosphere.

   (b) Write a note on power transmitter through popes. [8+8]

8. (a) A 150 mm x 75 mm Venturimeter with $C_d = 0.98$ is to be replaced by an orifice meter having a value of $C_d = 0.6$. If both the meters are to give the same differential mercury manometer reading for a discharge of 100 lps and the inlet dia. to remain 150 mm, what should be the diameter of orifice.

   (b) What is the necessity of ventilation of weirs. [8+8]

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Code No: RR220301 **Set No. 3**

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1. (a) Explain from microscopic point of view, the concept of viscosity. Explain how viscosity of liquids and gases behave with temperature.
   (b) A thin plate of large area is placed midway in a gap of height h filled with oil of viscosity μ_0 and the plate is pulled at a constant velocity V. If a lighter oil of viscosity μ_1 is then substituted in the gap, it is found that for the same velocity V, the drag force will be the same as before if the plate is located unsymmetrically in the gap but parallel to the walls. Find μ_1 in terms of μ_0 and the distance from the nearer wall to the plate. [8+8]

2. (a) Define and distinguish between steady flow and uniform flow. Give two examples of each flow.
   (b) Derive continuity equation for 1-D flow. [8+8]

3. (a) Derive an expression for Bernoulli's equations for flow along a stream line.
   (b) A U - tube contains a liquid of relative density 1.25 to a height of 25 cm in both the columns. It is rotated about a symmetrical vertical axis which is 15 cm from both the limbs. Calculate the pressures at the bottom horizontal connecting points and mid point when the speed of rotation is 240 rpm.[8+8]

4. (a) What is the physical significance of displacement thickness of boundary layer theory?
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   (c) The velocity distribution in the boundary layer was found to fit the equation $(u/U) = (y/d)^{1/7}$. Find the displacement thickness. [4+4+8]

5. (a) What is mach number? Why is this parameter is so important for the study of flow of compressible fluid?
   (b) A supersonic aircraft flies at an altitude of 1.8 Km where the temperature is 4^0C. Determine the speed of aircraft if its sound is heard 4 second after its passage over the head of observer.Take$\gamma = 1.4 and R = 281.43 J/Kg^0$K. [8+8]

6. (a) Explain Reynolds number and its significance in detail? What is the significance of upper and lower critical Reynolds numbers.

(b) A viscous fluid of viscosity 2.2 poise and specific gravity 1.4 flows through a 40 cm diameter pipe. If the loss of head is 3 m in 100 m length, determine the shear stress at the wall pipe and velocity of flow assuming the flow to be laminar. [8+8]

7. (a) Define and explain the terms hydraulic gradient line and total energy line.

(b) A pipe 20cm diameter and 1800 m long connects two reservoirs one being 30m below the other. The pipe line crosses a ridge whose summit is 7.5m above the upper reservoir. What will be the minimum depth of the pipe below the summit of the ridge in order that the pressure at the apex doesn't fall below 7.5m vacuum. The length of the pipe from the upper reservoir to the apex is 300m. Taking f= 0.032 determine the rate of flow to the lower reservoir in lit/min. [8+8]

8. (a) An orifice meter is to be fitted into a horizontal pipe 20 cm dia, carrying oil of specific gravity 0.85 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 0.2m when the flow is 15Kg/sec, what should be the diameter of the orifice? Assume C_d= 0.62

(b) Write a detailed note on pressure gauges [8+8]

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1. (a) Define compressibility and bulk modulus of elasticity. Obtain an expression for the bulk modulus of elasticity K of a fluid in terms of the pressure p and the mass density.
   (b) Determine the pressure increase required to reduce the volume of water by 1.5%, if its bulk modulus of elasticity is 2.2 X 10^9 Pa. [8+8]

2. (a) Derive three dimensional continuity equation.
   (b) The x and y components in a three dimensional flow are given by
   $U = x^2 + z^2$ $\vartheta = y^2 + z^2$
   Find the simplest z − component of velocity that satisfies the continuity equation. [8+8]

3. (a) Derive Euler's equation of motion along a stream line. State assumptions made in the derivation.
   (b) In an inclined pipe of uniform diameter 25 cm, a pressure of 50 kPa was observed at section - 1 which was at elevation 10.0 m. At another section -2 at elevation 12.0 m the pressure was 20 kPa and the velocity was 1.25 m/s. Determine the direction of flow and the head loss between these two sections. The fluid in the pipe is water. [8+8]

4. (a) What forces influences the motion of (i) a ship (ii) a sub marine (iii)an aeroplane flying at suspension speed.
   (b) Define and derive the expression for displacement thickness.
   (c) For laminar boundary layer on a flat plate held parallel to a stream of uniform velocity, determine the location of the section where drag up to that section is twice the drag on remaining region. [4+8+4]

5. 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 the shock waves are 100 $KN/m^2 and 300^0 K$. Determine the Mach number, Pressure and down stream of shock wave. Also estimate the shock Strength. [16]

6. (a) Enumerate the characteristics of laminar flow? Give examples where such a flow is encountered.
   (b) Oil of absolute viscosity 1.5 poise and relative density 0.85 flows through a 30 cm diameter pipe. If the headloss in 3000m length of pipe is 20m, estimate the friction factor by assuming the flow to be laminar. [8+8]

7. (a) Sketch and explain the hydraulic gradient and total energy line for an inclined pipe and horizontal pipe discharging freely in atmosphere.
   (b) Write a note on power transmitter through popes. [8+8]

8. (a) Explain orifice meter in detail with diagram. Also derive an expression for finding out the actual discharge from a given orifice meter.
   (b) How will you find the discharge through or triangular notchv

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