Code No: A109212102 **R09** **Set No. 2**

II B.Tech I Semester Examinations,November 2010
MECHANICS OF FLUIDS
Aeronautical Engineering

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (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 specific gravity of Hg = 13.6. [4+11]

2. (a) Define coefficient of drag and lift and state the factors on which these coefficients depend.

   (b) A truck having a projected area of 6.5 m^2 travelling at 70 km/h has a total resistance of 2000 N. Of this 20 percent is due to rolling friction and 10 percent due to surface friction. The rest is due to form drag. Make calculations for the coefficients of form drag. Take $\rho = 1.22$ kg/m^3 for air. [8+7]

3. 2.57 kg of gas for which the ratio of specific heats is 1.35 occupies a volume of 0.15 m^3 at 10 bar and 500 K. The gas undergoes expansion to 0.6 m^3 and process of expansion may follow any one of the following cases:

   (a) Constant pressure,
   (b) Constant temperature,
   (c) Adiabatic
   (d) Polytropic law $pV^{1.32}$ = const.

   For these cases determine:

   (a) Final temperature,
   (b) Work done and
   (c) Heat interchange. [15]

4. A vessel cylindrical in shape and closed at the top and bottom is 200 mm in diameter and 0.15 m in height. The vessel is completely filled with water. If it is rotated about its vertical axis with a speed of 200 rpm, what is the total pressure force exerted by water on the top and bottom of the vessel? [15]

5. A horizontal circular tube of radius 'a' has a fixed coaxial cylindrical core of radius b. τ_a and τ_b are the shear stresses along the tube and core surfaces when a viscous

liquid is flowing through the annulus. The flow is laminar and the rate of variation of pressure along the length of the passage is $\left(-\frac{\partial p}{\partial l}\right)$ Show that:
$a\tau_a - b.\tau_b = \frac{1}{2}(a^2 - b^2)\left(\frac{\partial p}{\partial l}\right)$. [15]

6. Explain the terms geometric similarity, kinematic similarity and dynamic similarity and discuss the difficulties faced in satisfying these three similarity laws in modeling studies. [15]

7. (a) A solid cone of radius R, height h and relative density 0.70 floats in fresh water with its axis vertical and vertex downwards. Determine the minimum value of R/h.

   (b) Define and explain the terms metacentre and metacentric height. [10+5]

8. (a) Under what conditions a stream line coincides with a streak line.

   (b) A stream function is given by the expression $\Psi = 2x^2 + y^3$. Find the components of velocity, as well as the resultant velocity a point (3,1). [8+7]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: A109212102 **R09** **Set No. 4**

II B.Tech I Semester Examinations,November 2010
MECHANICS OF FLUIDS
Aeronautical Engineering

Time: 3 hours Max Marks: 75

Answer any FIVE Questions
All Questions carry equal marks
⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Show that in a laminar steady flow the pressure gradient in the direction of motion is equal to the shear gradient normal to the direction of motion.
   (b) A pipe 200 mm in diameter, 20 km long conveys oil of density 900 kg/m^3 and viscosity 0.08 Ns/m^2 at 10 litres/second. Find the power required to maintain the flow. [8+7]

2. A pipe converges uniformly from 0.5 m diameter to 0.25 m over 2.5 m length. The rate of flow changes uniformly from 25 l/s to 50 l/s in 40 seconds. Find the total acceleration at the middle of the pipe at 20^{th} second. [15]

3. (a) Discuss the basic components of total drag.
   (b) A kite of dimensions 0.7 m × 0.7 m and weighing 6 N assumes an angle of 8^0 to the horizontal and the string attached to the kite makes an angle of 45^0 to the horizontal. The pull on the string is 25 N when the wind is blowing at a speed of 40 km/hr. Find the lift and drag forces and the corresponding lift and drag coefficients. The density of air is given as 1.2 kg./m^3. [4+11]

4. A 600mm diameter pipeline carries water under a head of 30m with a velocity of 3m/s. This water main is fitted with a horizontal bend which turns the axis of the pipeline through 75^0 (i.e. the internal angle at the bend is 105^0). Calculate the resultant force on the bend and its angle to the horizontal. [15]

5. (a) Explain with a neat sketch the working of a Bourdon Gauge.
   (b) Define the term metacentric height and explain its significance in stability of floating bodies. [8+7]

6. (a) How is a shock wave produced in a compressible fluid? What do you mean by the term "Shock strength"?
   (b) A gas with a velocity of 300 m/s is flowing through a horizontal pipe at a section where pressure is 60 kN/m^2 (abs.) and temperature 40 ^{0}C. The pipe changes in diameter and at this section the pressure is 90 kN/m^2. If the flow of gas is adiabatic find the velocity of gas at this section. Take R = 287 J/kgK and $\gamma = 1.4$. [5+10]

7. (a) Find an expression for the ratio of the outlet area of the nozzle to the area of the pipe for maximum transmission of power.

(b) A fire engine supplies water to a hose pipe, 75 m long and 0.075 m in diameter, at a pressure of 294 kN/m^2 (gauge). The discharge end of the hosepipe has a nozzle of diameter 'd' fixed to it. Taking friction factor as 0.032, determine the diameter 'd' of the nozzle, so that the momentum of the issuing jet may be a maximum. [5+10]

8. (a) What do you mean by model testing? What are pre requisites for model testing?

(b) Properties of a structure can be calculated by analytical method and by model analysis, which is more suitable? Why? [8+7]

⋆⋆⋆⋆⋆

Code No: A109212102 **R09** **Set No. 1**

II B.Tech I Semester Examinations,November 2010
MECHANICS OF FLUIDS
Aeronautical Engineering

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. The velocity distribution in a circular pipe is given by $\frac{\mu}{U_o} = \left(\frac{y}{R}\right)^{1/n}$ where u is the velocity at a distance y from the well of the pipe, Uo is the centerline velocity, R is the radius of the pipe and n an exponent. Calculate the energy correction factor. [15]

2. (a) Establish a relation for the average and maximum velocity for one-dimensional viscous flow of fluid between two fixed parallel plates.
   (b) An oil of viscosity 0.02 Pa-s flows between two stationary parallel plates which are kept at a distance of 10 mm apart. The plates are 1 m wide and the centerline flow velocity is stated to be 2.5 m/s. Make calculations for the average flow velocity, flow rate of oil, pressure gradient and the wall shear stress. [5+10]

3. (a) i. What is stagnation point of an object immersed in fluid?
   ii. What is stagnation pressure?
   (b) In case of isentropic flow of a compressible fluid through a variable duct, show that
   $\frac{A}{A_c} = \frac{1}{M}\left[\frac{1+\frac{1}{2}(\gamma-1)M^2}{\frac{1}{2}(\gamma+1)}\right]^{\frac{\gamma+1}{2(\gamma-1)}}$
   where γ is the ratio of specific heats, M is the Mach number at a section whose area is A and A_c is the critical area of flow. [8+7]

4. An oil of specific gravity 0.9 and viscosity 0.03 poise is to be transported at the rate of 3000 l/s through a 1.5 m diameter pipe. Tests were conducted on a 15 cm diameter pipe using water. If the viscosity of water is 0.01 poise find velocity of flow in the model and the rate of flow in the model. [15]

5. (a) Define the terms stream line, streak line and path line.
   (b) Show that the stream function and velocity potential intersect orthogonally. [8+7]

6. (a) Two vertical parallel glass plates at distance 't' apart are partially submerged in a liquid of specific weight γ and surface tension σ. Show that the capillary rise is given by
   $h = \frac{2\sigma Cos\theta}{t\gamma}$
   Make necessary assumptions.
   (b) Derive the expression for the total pressure and centre of pressure for a submerged inclined plane surface. [8+7]

7. (a) Develop a formula to determine the equivalent diameter of a compound pipe.

(b) A compound pipe line made of 900 m long, 45 cm diameter, 450 m long and 37.5 cm diameter and 300 m long and 30 cm diameter is to be replaced by a single uniform diameter pipe line having the length equal to compound pipe line and the flow remains same. Find the diameter required for uniform pipe line. Take f is same for all pipe lines and neglect minor losses in both cases. [4+11]

8. (a) The velocity distribution for the boundary layer along a flat plate is prescribed by a power law $\frac{u}{U} = \left(\frac{y}{\delta}\right)^{0.22}$. Find the displacement thickness δ^*, momentum thickness θ and energy thickness δ^{**} where δ is the nominal thickness of boundary layer. U is the free stream velocity.

(b) Atmospheric air at 25^0C flows parallel to a flat at a velocity of 3m/s. Use the exact Blasius solutions to estimate the boundary layer thickness and the local skin friction coefficient at x=1 m from the leading edge of the plate. How these values would compare with the corresponding values obtained from the approximate Von-Karman integral techniques assuming cubic velocity profile. [9+6]

⋆⋆⋆⋆⋆

Code No: A109212102 **R09** **Set No. 3**

II B.Tech I Semester Examinations,November 2010
MECHANICS OF FLUIDS
Aeronautical Engineering

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Differentiate between
   i. solid and fluid and
   ii. ideal fluid and real fluid.

   (b) Determine the bulk modulus of elasticity of a liquid, if the pressure of the liquid is increased from 7 MN/m^2 to 13 MN/m^2 and consequently the volume of the liquid decreases by 0.15%. [8+7]

2. (a) Define the terms: Major energy losses and minor energy losses in pipe.

   (b) Water flows through a pipe of diameter 300 mm with a velocity of 5 m/s. If the coefficient of friction is given by $f = 0.015 + \frac{0.08}{\mathrm{Re}^{0.3}}$ where Re is the Reynolds number, find the head lost due to friction for a length of 10 m. Take kinematic viscosity of water as 0.01 stoke. [5+10]

3. (a) Describe Reynolds experiments to demonstrate the laminar and turbulent fluid flows. How is the type of flow related to Reynold number?

   (b) Determine the nature of flow when an oil of specific gravity 0.85 and kinematic viscosity 1.8×10^{-5} m^2/s flows in a 10 cm diameter pipe at 0.5 liter per second. [8+7]

4. The outlet pipe from a pump is a bend of 45^0 rising in the vertical plane (i.e. and internal angle of 135^0). The bend is 150mm diameter at its inlet and 300mm diameter at its outlet. The pipe axis at the inlet is horizontal and at the outlet it is 1m higher. By neglecting friction, calculate the force and its direction if the inlet pressure is 100kN/m^2 and the flow of water through the pipe is 0.3m^3/s. The volume of the pipe is 0.075m^3. [15]

5. With a neat sketch, explain the different types of deformations that a fluid particle undergoes and derive the condition for the flow to be irrotational. [15]

6. (a) Explain the concept of stagnation properties.

   (b) A supersonic plane flies at 2000 km/hr at an altitude of 9 km above sea level in standard atmosphere. If the pressure and density of air at this altitude are stated to be 30 kN/m^2 absolute and 0.45 kg/m^3, make calculations for the pressure, temperature and density at the stagnation point on the nose of the plane. Take R = 287 J/kg K and $\gamma = 1.4$. [8+7]

7. (a) Set up Navier-Stokes's equations and make suitable assumptions to prove that 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.

   (b) Examine whether or not the following velocity profiles satisfy the essential boundary conditions for velocity distribution in the laminar boundary layer on a flat plate:

      i. $\frac{u}{U} = 1 + \left(\frac{y}{\delta}\right) - 2\left(\frac{y}{\delta}\right)^2$

      ii. $\frac{u}{U} = \sin(\pi y/2\delta)$

      Where δ is boundary thickness and U is free stream velocity. [8+7]

8. 215 liters of gasoline (Specific gravity=0.82) flows per second upwards in an inclined venturimeter fitted to a 300 mm diameter pipe. The venturimeter is inclined at 60^0 to the vertical & its 150 mm diameter throat is 1.2 m from the entrance along its length. Pressure gages inserted at entrance and throat show pressures of 0.141 N/mm^2 and 0.077 N/mm^2 respectively. Calculate C_d of the venturimeter. If instead of pressure gages the entrance and the throat of the venturimeter are connected to the two limbs of a U-tube mercury manometer, find its reading in mm of differential mercury column. [15]

⋆⋆⋆⋆⋆