Code No: 43035/43036 **R07** **Set No - 1**

II B.Tech I Semester Regular Examinations,Nov/Dec 2009
MECHANICS OF FLUIDS
Aeronautical Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Identify the common features and differences between stream and velocity potential functions.
   (b) Examine whether the velocity field U = 2ax($3y^2$-x2) and V = 2ay ($3x^2$-y^2) represent a possible two dimensional in compressible fluid flow. [8+8]

2. Derive an expression for the discharge over a sharp crested rectangular weir. A sharp edged weir is to be constructed across a stream in which the normal flow is 200 litres/sec. If the maximum flow likely to occur in the stream is 5 times the normal flow then determine the length of weir necessary to limit the rise in water level to 38.4cm above that for normal flow. C_d=0.61. [16]

3. (a) Explain in different losses that take place when the fluid flows through a pipe.
   (b) A pipe carrying the water at the rate of 3 m^3/min reduced suddenly from 20 cm to 10 cm. The pressure head just before contraction is 0.6 m greater than that of the pressure before the contraction. Determine the coefficient of contraction. [4+12]

4. (a) Explain the characteristics of laminar and turbulent boundary layers.
   (b) A plate 450 mm × 150 mm has been placed longitudinally in a stream of crude oil (specific gravity 0.925 and kinematic viscosity of 0.9 stoke) which flows with velocity of 6 m/s. Calculate:
      i. The friction drag on the plate,
      ii. Thickness of the boundary layer at the trailing edge and
      iii. Shear stress at the trailing edge. [6+10]

5. 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 (i.e. the internal angle at the bend is 105). Calculate the resultant force on the bend and its angle to the horizontal. [16]

6. (a) How is turbulent motion classified?
   (b) In a pipe of 300 mm diameter having turbulent flow, the center-line velocity is 6 m/s and that at 50 mm from the pipe wall is 5 m/s. Calculate the shear friction velocity. [6+10]

7. (a) A supersonic plane at a height H from the ground is flying. The observer on the ground hears the sonic boom t seconds after passing the plane over his

head. Prove that, the Mach number of the flying plane is given by
$\frac{1}{M} = \sqrt{1 - \left(\frac{Ct}{H}\right)^2}$
where C is the sound speed.

(b) Find the sonic velocity for the following fluids:

i. Crude oil, $\rho = 800$ kg/m^3 and K = 1530 MN/m^2,
ii. Mercury, p = 13600 kg/m^3 and K = 27000 MN/m^2. [10+6]

8. (a) The face of a dam is vertical to a depth of 7.5m below the water surface then slopes at 30^o to the vertical. If the depth of water is 17m what is the resultant force per meter acting on the whole face?

(b) With the help of rheological diagram, explain the various types of fluids.[8+8]

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MECHANICS OF FLUIDS
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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. The velocity vector in an incompressible flow is given by
$V = (6xt+yz^2)i+(3t+xy^2)j+(xy-2xyz-6tz)k$
   (a) Verify whether the continuity equitation is satisfied
   (b) Determine the acceleration vector at point A(1,1,1) at t = 1.0 [8+8]

2. (a) Explain why the drag of a rough sphere or cylinder is less than the drag of a smooth sphere or cylinder at Reynolds number 2×10^5?
   (b) A rotational mixing device is constructed with two circular disks each 10 cm in diameter. These disks are spaced 1 m apart on the two ends of a horizontal rod whose centre has a vertical shaft attached to it. Estimate the power required for rotation when this mixer turns 60 revolutions per minute in a solution having the following fluid properties: $\rho = 950$ kg/m^3, and $\mu = 0.08075$ kg m/s. For 3000 < Re < 5000, take $C_D = 1.2$. [6+10]

3. (a) Define Reynold's number. What is the relationship of friction factor with Reynold number for different types of pipes?
   (b) Water is flowing through a pipe of 40 cm diameter pipe and of 60 m length with a velocity of 4 m/s. Find the head loss using Darcy's formula and Chezy's formula where $C_h = 60$. Take v = 0.012 stokes for water. [8+8]

4. A 7.2m high and 15m long spillway discharges 94 m^3/s under a head of 2.0m. If a 1:9 scale model of this spillway is to be constructed, find the model dimensions, head over the model and the model discharge. [16]

5. The space between two large flat and parallel walls, 25 mm apart is filled with a liquid of viscosity 0.7 Pa.s. Within this space a thin flat plate, 250 mm × 250 mm is towed at a velocity of 15 cm/s at a distance 6 mm from one wall, the plate and the movement parallel to the walls. Assuming linear variation of velocity between the plate and the walls, determine the force exerted by the liquid on the plate.[16]

6. In a vertical pipe carrying water, pressure gauges are inserted at points A and B where the pipe diameters are 0.15m and 0.075m respectively. The point B is 2.5m below A and when the flow rate down the pipe is 0.02 cumecs, the pressure at B is 14715 N/m2 greater than that at A.
Assuming the losses in the pipe between A and B can be expressed as $k\,\frac{v^2}{2g}$ where v is the velocity at A, find the value of k.If the gauges at A and B are replaced by tubes filled with water and connected to a U-tube containing mercury of relative density 13.6, give a sketch showing how the levels in the two limbs of the U-tube

differ and calculate the value of this difference in metres.

[16]

7. At some section in the convergent-divergent nozzle, in which air is flowing, pressure, velocity, temperature and cross-sectional area are 200 kN/m^2, 170 m/s, 200 ^{0}C and 1000 mm^2 respectively. If the flow conditions are isentropic, determine:
   (a) Stagnation temperature and stagnation pressure,
   (b) Sonic velocity and Mach number at this section,
   (c) Velocity, Mach number and flow area at outlet section where pressure is 110 kN/m^2
   (d) Pressure, temperature, velocity and flow area at throat of the nozzle. [16]

8. (a) What are the characteristics of turbulent flow?
   (b) A pipeline carrying water has surface protrusions of average height of 0.15 mm. If the shear stress developed is 4.9 N/m^2, determine whether the pipe surface acts a smooth, rough or in transition. The kinematic viscosity of water may be taken as 0.01 stokes. [8+8]

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Code No: 43035/43036 **R07** **Set No - 3**

II B.Tech I Semester Regular Examinations,Nov/Dec 2009
MECHANICS OF FLUIDS
Aeronautical Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (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+8]

2. (a) Explain the difference between ideal fluid and real fluid.
   (b) A wooden block of size 2m × 1m × 0.8 m is floating in water. If its specific gravity is 0.7 find its metacentric height. [6+10]

3. (a) What do you understand by the terms: Major energy loss and Minor energy losses in pipes?
   (b) What do you understand by total energy line, hydraulic gradient line, pipes in series, pipes in parallel and equivalent pipe? [4+8]

4. A pipe 200 m long slopes down at 1 in 100 and tapers from 800 mm diameter at the higher end to 400 mm diameter at the lower end, and carries 100 l/s of oil. (Specific gravity of oil is 0.85). If the pressure at the higher end reads 50 kN/m^2, determine
   (a) the velocities at the two ends, and
   (b) pressure at the lower end. Assume that the losses are negligible.
   [16]

5. (a) Explain why air flowing at low velocities can be considered incompressible?
   (b) A pitot-static tube is inserted into an airstream and the mercury manometer connected differentially to it shows a difference in levels of 600 mm. The free stream pressure and temperature are 101.3 kN/m^2 absolute and 288 K respectively. Calculate the air velocity considering air to be compressible. What percentage error in velocity calculations would be committed if the air flow is considered as incompressible? [4+12]

6. Water flowing in a certain 20mm pipe becomes turbulent at a velocity of 11.4cm/s. What is the maximum velocity for the flow of air to be laminar in a pipe 40mm diameter of similar construction? Take viscosity of water = 1.12 x 10^{-3} kg/m-s and air as 17.7 N-s/m^2, density of water = 1000 kg/m^3 and air =1.23 kg/m^3. [16]

7. (a) Define

i. Path line
ii. Stream line
iii. Streak line
iv. Stream tube.

(b) Show that $\Psi = x^2 - y^2$ represents a two dimensional irrotational flow. Find the potential function. [8+8]

8. (a) How will you find the drag on a flat plate due to laminar and turbulent boundary layers?

(b) For the velocity profile for turbulent boundary layer $\frac{u}{U} = \left(\frac{y}{\delta}\right)^{\frac{1}{7}}$, obtain an expression foe boundary layer thickness, shear stress, drag force on one side of the plate and co-efficient of drag in terms of Reynolds number. Given the shear stress (t0) for turbulent boundary layer as $\tau_0 = 0.0225\rho U^2 \left(\frac{\mu}{\rho U \delta}\right)^{\frac{1}{4}}$. [4+12]

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Code No: 43035/43036 **R07** **Set No - 4**

II B.Tech I Semester Regular Examinations,Nov/Dec 2009
MECHANICS OF FLUIDS
Aeronautical Engineering

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

Answer any FIVE Questions
All Questions carry equal marks
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1. Starting from basic principles derive Euler's equation motion for a three dimensional flow, explaining the assumptions made. [16]

2. (a) For the laminar flow through a circular pipe, prove that:
   i. The shear stress variation across the section of the pipe is linear and
   ii. The velocity variation is parabolic.

   (b) Water is flowing between two large parallel plates which are 2.0 mm apart. Determine:
   i. Maximum velocity,
   ii. The pressure drop per unit length and
   iii. The shear stress at walls of the plate if the average velocity is 0.4 m/s. Take viscosity of water as 0.01 poise. [16]

3. A venturimeter 300 mm × 150 mm is used to measure the discharge of water in a 300 mm diameter horizontal pipe. If the pressure difference between entrance and throat is 3 m of water and if loss of head between the same sections is 1/8 of velocity head at the throat, calculate the discharge in pipe and the coefficient of the meter. [16]

4. Inside a 60 mm diameter cylinder a piston of 59 mm diameter rotates concentrically. Both the cylinder and piston are 80 mm long. If the space between the cylinder and piston is filled with oil of viscosity 0.3 N-s/m^2 and a torque of 1.5 Nm is applied find the speed of the piston and the power required. [16]

5. (a) Derive an expression for the loss of head due to:
   i. Sudden enlargement,
   ii. Sudden contraction of a pipe.

   (b) The rate of flow of water through a horizontal pipe is 0.3 m^3/s. The diameter of the pipe is suddenly enlarged from 250 mm to 500 mm. The pressure intensity in the smaller pipe is 13.734 N/cm^2. Determine:
   i. Loss of head due to sudden enlargement,
   ii. Pressure intensity in the large pipe and
   iii. Power lost due to enlargement. [8+8]

6. (a) Derive an expression for lift for uniform flow around a circular cylinder with clockwise circulation.

(b) A cylinder of 300 mm diameter is rotated at 150 rpm fully immersed in water of velocity 5 m/s. The velocity of water is normal to the axis of the cylinder. Determine:

i. The magnitude of the lift force experienced by the cylinder,

ii. The position of the stagnation points,

iii. The minimum rotational speed for the detached stagnation in the flow and

iv. The maximum uniform velocity for detached stagnation on the cylinder if the rotational speed is kept at 150 rpm. [8+8]

7. (a) The velocity at a point is given by V = $(4t+3x^2+2y)i+(t^2+2xy+3y^2)j$. Determine the local acceleration and total acceleration at a point (2,3) for t = 1.5 second

(b) Define a stream line and obtain an equation for it. Enumerate the properties of stream lines. [8+8]

8. (a) Describe compressible flow through a convergent-divergent nozzle. How and where does the shock wave occur in the nozzle?

(b) For a normal shock wave in air Mach number is 2. If the atmospheric pressure and air density are 26.5 kN/m^2 and 0.413 kg/m^3 respectively, determine the flow conditions before and after the shock wave. Take $\gamma = 1.4$. [4+12]

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