Code: 9A21404

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

MECHANICS OF FLUIDS

(Aeronautical Engineering)

Time: 3 hours Max. Marks: 70

Answer any FIVE questions

All questions carry equal marks

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1 (a) Discuss the important properties of fluids along with their units and practical significance.

(b) Two large plane surfaces are 25 mm apart. This space is filled with glycerin of dynamic viscosity 0.804 N – sec/m^2. Find what force is required to drag a very thin plate of area 0.05 m^2 between the two surfaces at a speed of 0.60 m/sec.
(i) If the plate is equidistant from the two surfaces.
(ii) If the plate is 10 mm from one of the surfaces.

2 (a) Explain the terms:
(i) Path line (ii) Streak line (iii) Stream line (iv) Stream tube.

(b) A stream function follows the law $\psi = x^2 - y^2$ determine the velocity potential function.

3 (a) State and prove Bernoulli's theorem with a neat sketch and mention its limitations.

(b) In a two-dimensional incompressible flow, the fluid velocity components are given by u = x – 4y and v = -y – 4x. Show that the velocity potential exists and determine its form. Find also the stream function.

4 (a) Explain:
(i) Hydraulic gradient line (ii) Total energy line.

(b) An orifice meter with orifice diameter 15 cm, is inserted in a pipe of 30 cm. The pressure difference measured by a mercury-oil differential manometer on the sides of the orifice meter gives a reading of 50 cm, of mercury. Find the rate of flow of oil of specific gravity 0.9 when the co-efficient of discharge of the meter is 0.64.

5 (a) Define the following terms:
(i) Laminar boundary layer. (ii) Turbulent boundary layer.
(iii) Laminar sub layer. (iv) Boundary layer thickness.

(b) A 2 m wide and 5.0 long plate when towed through water at 20℃ experiences a drag of 30.38 N on both the sides. Determine the velocity of the plate and the length over which the boundary layer is laminar.

6 (a) Derive the Darcy-Weisbach equation.

(b) A pipe line, 50 cm diameter and 4500 m long, connects two reservoirs A and B whose constant difference of water level is 12 m. A branch pipe, 1250 m long and taken from a point distant 1500 m from reservoir A, leads to reservoir C whose water level is 15 m below that of reservoir A, find the discharges to the reservoir B and C. Assume Darcy's friction coefficient of 0.03 for all pipes.

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

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

8 (a) (i) When is the compressibility of fluid important?
(ii) What is the difference between isentropic and adiabatic flows?

(b) A horizontal pipe of diameter 60 mm reduces to a diameter of 30 mm through a sudden contraction in which gas is owing at a temperature of 6℃. The pressure at the sections 1 and 2 are 4 bar (gauge) and 3 bar (gauge) respectively. If R = 287 J/kg-K and atmospheric pressure is 1 bar find the velocities of the gas at these sections.

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2

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1 (a) What are the important fluid properties? Write their units. Derive the equation of hydrostatic pressure variation.

(b) Find the kinematic viscosity in stokes for a liquid with specific gravity 0.95 and dynamic viscosity 0.011 poise.

2 (a) The stream function for a two dimensional plane flow is given by $\psi = 2xy$. Determine the velocity potential function if it exists.

(b) Differentiate between uniform flow and steady flow giving suitable examples.

3 (a) Define the equation of continuity. Obtain an express for continuity equation for a one dimensional flow.

(b) Prove that the centre of pressure of a completely submerged plane surface is always below the centre of gravity of the submerged surface or at most coincide with centre of gravity when the plane surface is horizontal.

4 (a) Integrate-three dimensional Euler's equations for steady flow condition and prove that each one of them yields Bernoulli's equation.

(b) A pipe of diameter 200 mm conveys a discharge of 2250 lit of water per minute and has a pressure of 15.70 kPa at a certain section. Find the total energy head with respect to a datum of 5 m below the pipe.

5 (a) It is stated that the pressure distribution within the boundary layer is determined by the outside flow which can be treated as in viscous fluid. Explain.

(b) A plate 25 m long of 1.25 m wide is moving under water in the direction of its length. The drag force on the two sides of the plate is estimated to be 8500 N. Calculate:

(i) The velocity of the plate.

(ii) The boundary layer thickness at the trailing edges of the plate and

(iii) The distance X_C at which the laminar boundary layer existing at the leading edge transforms into turbulent boundary layer. Take for water density = 1000 kg/m^3; v = 1 x 10^{-6} m^2/s.

6 (a) Explain:

(i) Characteristics of real fluids. (ii) Total energy line.

(b) Derive the expression for loss of head due to friction in pipes.

7 (a) Define Reynolds number and obtain expression for the Reynolds number. Also explain its significance.

(b) From a reservoir two parallel pipes of diameter 180 mm and 250 mm each 125 m long convey a total discharge of 0.18 m^3/sec, find the head loss due to friction. If however, the two pipes are arranged in series to convey the same discharge what would be the head lost due to friction. Take 4f = 0.03.

8 Air flows through around a submerged abject. At section 1 in the approaching system the pressure P_1 = 101.043 KN/m^2, the density ρ_1=1.226 kg/m^3 and the velocity V_1=135 m/s. At section II near the object, the pressure P_2 is observed to be 39.24 KN/m^2. Calculate

(i) The temperature ratio between these two points and

(ii) The mach number at each point. Take K = 1.4 and R = 287 J/kg.K.

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3

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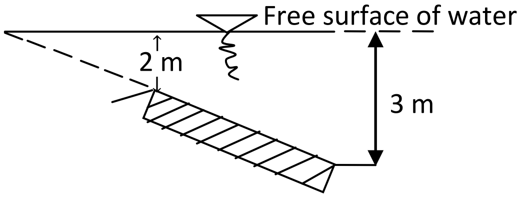
1 (a) Write a short note on the following:
(i) Hydrostatic pressure. (ii) Total pressure and centre of pressure.

(b) A circular plate 2.5 m in diameter is submerged in water as shown in figure. Its greatest and least depths below free surface of water are 3 m and 2 m respectively. Find
(i) Total pressure on front face of the plate and (ii) The position of centre of pressure.



2 (a) Derive the continuity equation for 3-D fluid flow.

(b) A fluid field is given by V = xyi+2yzj-(yz+z^2)k determine whether this is a possible steady incompressible fluid flow. If so, determine the value of rotation at the point P (1,2,3)

3 (a) Derive Bernoulli's equation for flow along a stream line.

(b) 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 lps of oil (S = 0.85). If the pressure gauge reading at the higher end reads 50 kN/m^2. Determine.
(i) Velocities at the two ends and (ii) pressure at the lower end. Neglect losses.

4 (a) Differentiate notches and weirs and classify the notches.

(b) A pipe of diameter 200 mm conveys a discharge of 2250 lit of water per minute and has a pressure of 15.70 kPa at a certain section. Find the total energy head with respect to a datum of 5 m below the pipe.

5 (a) What is meant by smooth boundary and a rough boundary?

(b) Describe briefly the phenomenon of boundary layer separation.

(c) At what wind speed must a 127 mm diameter sphere travel through water to have drag of 5 N.

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
(i) the total energy line (ii) 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) Write short notes on Reynolds number, mach number, mach angle and zone of action.

(b) A supersonic airflow flies at an altitude of 2 KM where the temperature is 4℃. Determine the speed of aircraft it its sound is heard 4 seconds after its passage over the head of observer. Take K = 1.4 and R = 281.43 J/Kg K.

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 owing through a horizontal pipe at a temperature of 4℃. The diameter of the pipe is 8 cm and at a section 1 in the pipe, the pressure is 30.3 N/cm^2 (gauge). The diameter of the pipe changes from 8 cm to 4 cm at the section II, where pressure is 20.3 N/cm^2 (gauge). Find the velocities of the gas at these sections assuming an isothermal process. Take R = 287.14 Nm/Kg.K and atmosphere pressure = 10 N/cm^2.

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4

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1 (a) What are the different types of manometer and explain?
  (b) Prove that the centre of pressure of a completely submerged plane surface is always below the centre of gravity of the submerged surface or at most coincide with centre of gravity when the plane surface is horizontal.

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

3 (a) Define the terms (i) forced vertex flow (ii) free vortex flow. Give suitable examples.
  (b) A rectangular duct of width 25 cm has a two dimensional irrotational flow. It has an elbow made up of circular arcs of radius 40 cm and 65 cm for the inner and outer walls respectively. Calculate the discharge per unit width of the duct when the difference in pressure between outer and inner walls in the elbow is 30 kPa.

4 (a) Explain the working principle of venturimeter and orifice meter.
  (b) (i) A broad crested weir of 50 mts length has 50 cms height of water above its crest. Find the maximum discharge. Take C_d = 0.6. Neglect velocity of approach.
  (ii) If the velocity of approach is to be taken into consideration, find the maximum discharge when the channel has cross sectional area of 50 m^2 on the upstream side.

5 (a) Explain with a neat sketch the boundary layer characteristics when a fluid is flowing over at a plate.
  (b) A thin at plate 0.3 m wide and 0.6 m long is suspended and exposed parallel to air owing 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.

6 (a) What are different types of drag? What is streamlining? What is its effect on the different types of drag?
  (b) Explain minor losses in the pipes in series and parallel.

7 (a) What do you meant by viscous flow? Mention various forces to be considered in Navier Stroke's equation.
  (b) Derive an expression for the loss of head due to sudden contraction in a pipe.

8 (a) Define compressible and incompressible flows.
  (b) Find the mass rate of flow of air through a venturimeter having inlet diameter as 300 mm and throat diameter 150 mm. The pressure at the inlet of venturimeter is 1.4 x 9.81 N/cm^2 and temperature of air at inlet 150 C. The pressure at the throat is given as 1.3 x 9.81 N/cm^2 absolute. Take R = 287 J/kg.K and K = 1.4.

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