B.E. (Aeronautical Engineering) Third Semester (C.B.S.)

Fluid Mechanics & Machineries Paper - III

P. Pages : 3 **TKN/KS/16/7348**

Time : Three Hours Max. Marks : 80

1095

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Diagrams and chemical equations should be given whenever necessary.
11. Illustrate your answers whenever necessary with the help of neat sketches.
12. Use of non programmable calculator is permitted.

1. a) Enunciate Newton's law of viscosity. Explain the importance of viscosity in fluid motion. What is the effect of temperature on viscosity of water and that of air? **5**

b) Assuming that the bulk modulus of elasticity of water is $2.07 \times 10^6\ \mathrm{kN/m^2}$ at standard atmospheric conditions, determine the increase of pressure necessary to produce 1% reduction in volume at the same temperature. **4**

c) A cylinder of $0.9\,\mathrm{m^3}$ in volume contains air at 0ºc and $39.24\,\mathrm{N/cm^2}$ absolute pressure. The air is compressed to $0.45\,\mathrm{m^3}$. Find **5**
   i) The pressure inside the cylinder assuming isothermal process,
   ii) Pressure & temperature assuming adiabatic process [Take k = 1.4 for air].

OR

2. a) Differentiate between: **6**
   i) Absolute and gauge pressure.
   ii) Simple manometer & differential manometer.
   iii) Piezometer & pressure gauges.

b) A pressure gauge consists of two cylindrical bulbs B & C each of 10 $\mathrm{cm^2}$ cross-sectional area, which are connected by a U-tube with vertical limbs each of $0.25\,\mathrm{cm^2}$ cross-sectional area. A red liquid of specific gravity 0.9 is filled into 'C' and clear water is filled into 'B', the surface of separation being in the limb attached of 'C'. Find the displacement of the surface of separation when the pressure on the surface in 'C' is greater than that in 'B' by an amount equal to 1cm head of water. **8**

3. a) Derive the Bernoulli's equation from Euler's equation and state assumptions. **6**

b) For a two dimensional flow the velocity potential function (ϕ) is given by an expression. **8**

$$\phi = \frac{-xy^3}{3} - x^2 + \frac{x^3 y}{3} + y^2$$

i) Find the velocity components in x & y direction.

ii) Show that ' ϕ ' represent a possible case of flow.

iii) Determine stream function & the flow rate between the stream lines (2, 0) & (2, 2)

iv) Show that the stream lines and velocity potential lines intersect orthogonally at the point (2, 2)

OR

4. a) What do you understand by the terms: **6**

i) Total acceleration. ii) Convective acceleration & iii) Local acceleration.

b) Define an orifice-meter. Prove that the discharge through an orifice-meter is given by the relation **8**

$$Q = e_d \frac{a_0 a_1}{\sqrt{a_1^2 - a_0^2}} \times \sqrt{2gh}$$

where a_1 = area of pipe in which orifice meter is fitted.

a_0 = area of orifice.

5. a) What is Hagen Poiseuille's Formula? Derive an expression for Hagen Poiseuille's formula. **5**

b) Prove that the maximum velocity in a circular pipe for viscous flow is equal to two times the average velocity of the flow. **5**

c) Describe Reynolds experiments to demonstrate the two types of flow. **3**

OR

6. a) What do you mean by separation of boundary layer? What is the effect of pressure gradient on boundary Layer separation? **5**

b) For the velocity profile given below, state whether the boundary layer has separated on the verge of separation on will remain attached with the surface. **8**

i) $\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$ ii) $\frac{u}{U} = -2\left(\frac{y}{\delta}\right) + \frac{1}{2}\left(\frac{y}{\delta}\right)^3$ and

iii) $\frac{u}{U} = \frac{3}{2}\left(\frac{y}{\delta}\right)^2 + \frac{1}{2}\left(\frac{y}{\delta}\right)^3$

7. a) What do you mean by gross head, net head & efficiency of turbine? Explain the different types of the efficiency of a turbine. **5**

b) The water available for a Pelton wheel is $4m^3$/sec and the total head from the reservoir to the nozzle is 250m. The turbine has two runners with two jets per runner. All the four jets have the same diameters. The pipe line is 3000m long. The efficiency of power transmission through the pipe line and the nozzle is 91% and efficiency of each runner is 90%. The velocity co-efficient of each nozzle is 0.975 and co-efficient of friction '4f' for the pipe is 0.0045. Determine : **8**

i) The power developed by the turbine. ii) The diameter of the jet and

iii) The diameter of the pipe line

OR

8. a) Define specific speed of a turbine and derive an expression for the same. Show that Pelton turbine is a low specific speed turbine. **6**

b) A Pelton wheel is revolving at a speed of 190 r.p.m. and develops 5150.25 kw when working under a head of 220m with an overall efficiency of 80%. Determine unit speed, unit discharge and unit power. The speed ratio for the turbine is given as 0.47. Find the speed, discharge and power when this turbine is working under a head of 140m. **7**

9. a) Prove that the work done per sec. per unit weight of water in a reaction turbine is given as **6**

$$= \frac{1}{g}\left(V_{w1} u_1 \pm V_{w2} u_2\right)$$

where V_{w1} & V_{w2} = Velocities of whirl at inlet and outlet.

u_1 & u_2 = Peripheral velocities at inlet & outlet.

b) A Kaplan turbine runner is to be designed to develop 9100 kw. The net available head is 5.6m. If the speed ratio = 2.09, flow ratio = 0.68, overall efficiency = 86% and the diameter of the boss is $1/3$ the diameter of the runner. Find the diameter of the runner, its speed and the specific speed of the turbine. **7**

OR

10. a) What are the uses of a draft – tube? Describe an expression for efficiency of draft-tube. **6**

b) A francis turbine with an overall efficiency of 75% is required to produce 148.25kw power. It is working under a head of 7.62m. The peripheral velocity $= 0.26\sqrt{2gH}$ and the radial velocity of flow at inlet is $0.96\sqrt{2gH}$. The wheel runs at 150 r.p.m. and the hydraulic losses in the turbine are 22% of the available energy. Assuming radial discharge, determine: **7**

i) The guide blade angle.
ii) The wheel vane angle at inlet.
iii) Diameter of the wheel at inlet.
iv) Width of the wheel at inlet

11. Write short notes on the following. **13**

i) Centrifugal pumps.
ii) Reciprocating pump.
iii) Vane pump.

OR

12. Write short notes on the following. **13**

i) Gear Pump.
ii) Axial flow pump.
iii) Positive displacement pump.

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