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Question Paper Code: 31074

B.E. / B.Tech. DEGREE EXAMINATION, OCTOBER 2014.

Third Semester

Mechanical Engineering

01UME304 – FLUID MECHANICS AND MACHINERY

(Regulation 2013)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions.

PART A - (10 x 2 = 20 Marks)

1. What do you mean by absolute pressure and gauge pressure?
2. Differentiate between steady and unsteady flow.
3. List the causes of minor energy losses in flow through pipes.
4. Define boundary layer and give its significance.
5. What is Dimensionally Homogeneous equation and give an example?
6. Define: (i) Euler number (ii) Mach number
7. State the momentum equation. When can it be applied?
8. Define specific speed of a turbine.
9. Why is priming necessary in centrifugal pumps?
10. What is an indicator diagram?

PART - B (5 x 16 = 80 Marks)

11. (a) (i) The velocity distribution over a plate is given by $u = 2y - y^2$, where u is the velocity in m/sec at a distance of y metre above the plate. Determine the velocity gradient and shear stress at the boundary and 1.5 m from it. Dynamic viscosity of the fluid is 0.9 Ns/m^2. (8)

(ii) Two large plane surfaces are 125 mm apart. The space between the surfaces is filled with oil of viscosity 0.972 Ns/m^2. A flat thin plate of 0.5 m^2 area moves through the oil at velocity of 0.3 m/s. Calculate the drag force

(a) When the plate is in the middle of the two plane surface and
(b) When the thin plate is at a distance of 30 mm from one of the planes. (8)

Or

(b) In a two dimensional incompressible flow the fluid velocities are given by $u = x - 4y$ and $u = -y - 4x$. Show that velocity potential exists and determine its form. Find also the stream function. (16)

12. (a) The discharge of water through at horizontal pipe is 0.25 m^3/s. The diameter of above pipe which is 200mm suddenly enlarges to 400mm at a point. If the pressure of water in the smaller diameter of pipe is 120 kN/m^2, determine loss of head due to sudden enlargement, pressure of water in the larger pipe and the power lost due to sudden enlargement. (16)

Or

(b) Compare the rate of growth of the laminar boundary layer over a smooth flat plate in the following cases:

(i) Flat plate placed in the water stream flowing at 1.5 m/s.
(ii) Flat plate in an air stream flowing at 2.5 m/s.
(iii) Flat plate placed in an air stream flowing at 8 m/s.

Given that the densities of water and air 1000 and 1.2 kg/m^3 respectively and the viscosities of water and air are 0.001 and 0.000019 $N\text{-}s/m^2$ respectively. (16)

13. (a) Using Buckingham's π Theorem, show that the velocity through circular orifice is given by: $V = \sqrt{2gH}\, f\left[\frac{D}{H}, \frac{\mu}{\rho VH}\right]$

where, H = Head causing flow
D = Diameter of orifice
μ = Coefficient of viscosity
ρ = Mass density
g = Acceleration due to gravity. (16)

Or

(b) The efficiency η of a fan depends on density ρ, dynamic viscosity μ of the fluid, angular velocity ω, diameter D of the rotor and the discharge Q. Express the efficiency η in terms of dimensionless parameter. (16)

14. (a) (i) A Pelton wheel has a mean bucket speed of 10 meters per second with a jet of water flowing at the rate of 700 litres/sec under a head of 30 meters. The buckets deflect the jet through an angle of 160^{o}. Calculate the power given by water to the runner and the hydraulic efficiency of the turbine. Assume coefficient of velocity 0.98. (8)

(ii) The Franics turbine with an overall efficiency of 76% and hydraulic efficiency of 80% is required to produce 150 kW. It is working under a head of 8 m. The peripheral velocity is 0.25 $\sqrt{2gH}$ and radial velocity of flow at inlet is 0.95 $\sqrt{2gH}$. The wheel runs at 150 r.p.m. Assuming radial discharge, determine

(a) Flow velocity at outlet
(b) The wheel angle at inlet
(c) Diameter and width of the wheel at inlet. (8)

Or

(b) A Kaplan turbine has a runner diameter of 4m and a hub diameter of 1.2m. The discharge through the turbine is 70 m^3/s. The hydraulic and mechanical efficiencies can be assumed to be 90% and 93% respectively. Assume there is no whirl at outlet. Estimate the net available head on the turbine and the power developed. If the speed ratio is 2.0, estimate the specific speed. (16)

15. (a) (i) A centrifugal pump running at 800 rpm is working against a total head of 20.2 m. The external diameter of the impeller is 480 mm and the outlet width is 60 mm. If the vane angle at outlet is 40^{o} and manometric efficiency is 70%, determine

(a) Flow velocity at outlet,
(b) Absolute velocity of water leaving the vane,
(c) Angle made by the absolute velocity at outlet with the direction of motion.
(d) Rate of the flow through the pump. (8)

(ii) Obtain an expression for work done by impeller of a centrifugal pump on water per second per unit weight of water. (8)

Or

(b) (i) The plunger diameter and stroke length of a single-acting reciprocating pump are 300 mm and 500 mm respectively. The speed of the pump is 60 rpm. The diameter and length of delivery pipe are 150 mm and 60 m respectively. If the pump is equipped with an air vessel on the delivery side at the centre lane of the pump, find the power saved in overcoming friction in the delivery pipe. Assume Darcy's friction factor as 0.04 and the plunger undergoes a simple harmonic motion. (8)

(ii) Compare the characteristics of Centrifugal Pump and Reciprocating Pump. (8)