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B. E. (Fifth Semester) Examination
Nov.-Dec. 2021

(New Scheme)

(Mech. Engg. Branch)

FLUID MACHINERY

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Attempt all question part (a) is compulsory of 2 marks. Attempt any* ***two*** *from (b), (c)* and *(d) of 7 marks.*

Unit-I

1. (a) Define momentum energy thickness.

(b) Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by

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

(c) For the velocity profile for turbulent boundary layer

$$\frac{u}{U} = \left[\frac{y}{\delta}\right]^{\frac{1}{7}}$$

Obtain an expression for boundary layer thickness, shear stress, drag force on one side of the plate and coefficient of drag in term of Raynold number. Given the shear stress (τ_0) for turbulent boundary layers as

$$\tau_0 = 0.0225\rho U^2 \left(\frac{\mu}{\rho\delta U}\right)^{1/4}$$

(d) A kite 0.8 m × 0.8 m weighing 0.4 kgf (3.924 N) assumes an angle, of 12° to the horizontal. The

string attached to the kite makes an angle of 45° to the horizontal. The pull on the string is 2·5 kgf (24.525 N) when the wind is flowing at a speed of 30 km/hour. Find the corresponding co-efficient of drag and lift. Density of air is given as 1.25 kg/m^3.

Unit-II

2. (a) Define the specific speed of turbine.

(b) Explain the construction and working of a Pelton wheel turbine with neat and clean diagram.

(c) Derive an expression for maximum hydraulic efficiency of a Pelton wheel turbine.

(d) A jet of water having a velcoity of 15 m/sec, strikes a curved vane which is moving with a velocity of 5 m/sec in the same direction as that of the jet at inlet. The vane is so shaped that the jet is deflected through 135°. The diameter of jet is 100 mm. Assume the vane to be smooth, find :

(i) Force exerted by the jet on the vane in the direction of motion.

(ii) Power exerted on the vane.

(iii) Efficiency of the vane.

Unit-III

3. (a) What is cavitation?

(b) Prove that the work done per second per unit weight of water in a reaction turbine is given as

$$= \frac{1}{g}\left(V_{w_1} u_1 \pm V_{w_2} u_2\right)$$

Where V_{w_1} and V_{w_2} = Velocities of whril at inlet and outlet u_1 and u_2 = Peripheral velocities at inlet and outlet.

(c) An inward flow reaction turbine has an external diameter of 1m and its breadth at inlet is 250 mm. If the velocity of flow at inlet is 2 m/s, find weight of water passing through the turbine per second. Assume 10% of the area of flow is blocked by the blade thickness. If the speed of the runner is 210 rpm, and guide blades make an angle of 10° to the

wheel tangent, draw the inlet velocity triangle and find (i) The runner vane angle at inlet (ii) The velocity of wheel at inlet (iii) The absolute velocity of water leasing the guide vane and (iv) The relative velocity of water entering runner blade.

(d) A Kaplan turbine develops 24647.6 kW power at an average head of 39 meter assuming a speed ratio of 2, flow ratio of 0.6, diameter of the boss equal to 0.35 times the diameter of the runner and an overall efficiency of 90%, calculate the diameter, speed and specific speed of specific speed of the turbine.

Unit-IV

4. (a) Define manometric and mechanical efficiencies of a centrifugal pump.

(b) Explain with neat sketch working of a centrifugal pump. Also explain various heads and various efficiencies of a centrifugal pump.

(c) A centrifugal pump delivers water against a net head of 14·5 m and a design speed of 1000 rpm. The vanes are curved back to an angle of 300 with the periphery. The impeller diameter is 300 mm and outlet width is 50 mm. Determine the discharge of the pump if manometric efficiency is 95%.

(d) The internal and external diameter of an impeller of a centrifugal pump which is running at 1450 rpm are 150 mm and 350 mm respectively. The discharge through pump is 0.08 m^3/s and the velocity of flow is constant and equal to 0.8 m/s. The diameters of the suction and delivery pipes are 80 mm and 60 mm respectively and suction and delivery heads are 6 m (abs.) and 30 m (abs.) N 1450 rpm Internal dia D1 150 mm 0.15 m External dia D2 350 mm 0.35 m are 80 mm and 60 mm respectively and sunction and delivery heads are 6 m (abs.) and 30 m (abs.) of water respectively. If the outlet vane angle is 45° and power required to drive the pump is 56.186 kW, determine (i) Vane angle of the impeller at inlet, (ii) The overall efficiency of the pump, and (iii) Manometric efficiency of the pump.

Unit-V

5. (a) Explain the function of air vessel?

(b) Explain working principle with neat sketch of a double acting reciprocating?

(c) The cylinder bore diameter of a single acting reciprocating pump is 150 mm and its stroke is 300 mm. The pump runs at 50 rpm and lifts water through a height of 25 m. The delivery pipe is 22 m long and 100 mm in diameter. Find the theoretical discharge and the theoretical power required to run the pump. If the actual discharge is 4.2 liters/s, Find the percentage slip. Also determine the acceleration head at the beginning and middle of the delivery stroke.

(d) A double-acting reciprocating pump, running at 40 rpm, is discharging 1.0 m^3 of watar per minute. The pump has a stroke of 400 mm. The diameter of the piston is 200 mm. The delivery and suction head are 20 m and 5 m respectively. Find the slip of the pump and power required to drive the pump.