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APR-MAY

B. E. (Fifth Semester) Examination, 2020

(Old Scheme)

(Mech. Engg. Branch)

FLUID MACHINERY

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Attempt all questions. Part (a) of each question is compulsory. Attempt any two part out of (b), (c) and (d). Part(a) carries 2 marks each & parts (b), (c) & (d) carry 7 marks each.*

Unit-I

1. (a) What do you mean by Boundary Layer? 2

(b) Prove the momentum thickness and energy thickness for boundary layer flows are given by 7

$$\theta = \int_0^{\delta} \frac{u}{U}\left(1-\frac{u}{U}\right)dy \text{ and}$$

$$\delta^{*} = \int_0^{\delta} \frac{u}{U}\left(1-\frac{u}{U^2}\right)dy$$

(c) Obtain Von Karman Momentum Integral equation. 7

(d) A flat plate 1·5 m × 1·5 m moves at 50 km/hr in stationery air density 1·15 kg/m^3. If the coefficients of drag and lift are 0·15 and 0·75 respectively, determine : 7

(i) The lift force,

(ii) The drag force,

(iii) The resultant force, and

(iv) The power required to keep the plate in motion.

Unit-II

2. (a) What is impulse momentum principle? 2

(b) Find the expression for efficiency of a series of curved vanes at one of its tips. Prove the Maximum efficiency is when $u = V$ and the value of maximum efficiency is 50%. 7

(c) A pelton wheel is having a mean bucket diameter of 1 m and is running at 1000 r.p.m. The net head on the pelton wheel is 700 m. If the side clearance angle is 15° and discharge through nozzle is 0·1 m^3/s, find : 7

(i) Power available at the nozzle, and

(ii) Hydraulic efficiency of the turbine.

(d) A pelton wheel is to designed for a head of 60 m when running at 200 r.p.m. The pelton wheel develops 95·6475 kW shaft power. The velocity of the buckets is 0·45 times the velocity of the jet, overall efficiency is 85% and the coefficient of velocity is equal to 0·98. 7

Unit-III

3. (a) What are the functions of the draft tube? 2

(b) In an inward flow reaction turbine the head on the turbine is 32 m. The external and internal diameters are 1·44 m and 0·72 m respectively. The velocity of flow through the runner is constant and equal to 3 m/s. The guide blade angle is 10° and the runner vanes are rigid at inlet. If the discharge at outlet is radial, determine : 7

(i) The speed of the turbine.

(ii) The vane angle at outlet of the runner, and

(iii) Hydraulic efficiency.

(c) An inward flow turbine runner has an outer diameter of 0·6 m and an inner diameter of 0·3 m and runs at 750 r.p.m. The radial velocity of flow at inlet and exit is 6 m/s. Water enters the runner making an angle of 12° to the direction of motion of the blades at inlet. It leaves the runner radially. The mass flow rate is 1 kg/s. Calculate : 7

(i) Power developed.

(ii) Angle between the relative velocity of water and tangential velocity of the runner at exit.

(d) What is Cavitation effect? How can it be avoided in reaction turbines? 7

Unit-IV

4. (a) Define priming of centrifugal pump. 2

(b) The impeller of a centrifugal pump has an external diameter of 450 mm and internal diameter of 200 mm and it runs at 1440 r.p.m. Assuming a constant radial flow through the impeller at 2·5 m/s and that the vanes at exit are set back at an angle 25°, determine : 7

(i) Inlet vane angle,

(ii) The angle, absolute velocity of water at exit makes with the tangent, and

(iii) The work done per N of water.

(c) Show that the rise of pressure in the impeller of a centrifugal pump when frictional and other losses in the impeller are neglected, is given by

$$\frac{1}{2g}\left[v_{f1}^{\,2} + u_2^{\,2} - v_{f2}^{\,2}\operatorname{cosec}^2\phi\right]$$

Where, v_{f1}, v_{f2} = Velocities of flow at inlet and outlet

u_2 = Tangential velocity of the impeller at outlet, and

ϕ = Vane angle at outlet. 7

(d) Why are centrifugal pumps used sometimes in series and sometimes in parallel? Draw the following characteristics curves for a centrifugal pump : Head, power and efficiency versus discharge with constant speed. 7

Unit-V

5. (a) What do you mean by air vessel? 2

(b) A single-acting reciprocating pump operating at 120 r.p.m. has a piston diameter of 200 mm and stroke of 300 mm. The suction and delivery heads are 4 m and 20 m, respectively. If the efficiency of both suction and delivery strokes is 75 percent, determine the power required by the pump. 7

(c) The diameter and stroke length of a single-acting reciprocating pump are 75 mm and 150 mm respectively. It takes it supply of water from a sump

3 m below the pump through a pipe 5 m long and 40 mm in diameter. It delivers water to a tank 12 m above the pump through a pipe 30 mm in diameter and 15 mm long. If separation occurs 75 kN/m^2 below the atmospheric pressure, find the maximum speed at which pump may be operated without separation. Assume that the piston has a simple harmonic motion. 7

(d) Describe with sketches the working of any **two** of the following hydraulic devices : 7

(i) Hydraulic crane

(ii) Hydraulic lift

(iii) Hydraulic press

(iv) Hydraulic coupling