B. M. E. 2nd Year 2nd Semester Examination, 2018

Fluid Machinery-I

Time:-Three Hours Full Marks:-100

Answer Any Five Questions

Assume any data relevant to the questions if not provided

1. a) Draw a neat sketch of a Pelton wheel along with the components. State the functions of each component. (10)

b) Derive the conditions for which the wheel efficiency for a Pelton wheel is maximum. (10)

2. a) What are the differences between an impulse turbine and a reaction turbine? Explain why cavitation does not occur for an impulse turbine. Draw the theoretical and actual efficiency vs. blade speed ratio curves for a Pelton wheel turbine. Explain why they differ. (08)

b) The following data is given for a Pelton wheel:
Head, H=350 m
Speed of the wheel, N=750 R.P.M.
Shaft power of the wheel, P=9560 KW
Speed Ratio=0.45
Co-efficient of velocity=0.985
Overall efficiency=85%
Jet diameter=1/6 of the wheel diameter.
Determine (1) The wheel diameter, (2) Diameter of the Jet and (3) Number of Jets required. (12)

3. a) Define different types of efficiency related to a centrifugal pump. How the head of a centrifugal pump can be increased? (8+2=10)

b) A centrifugal pump impeller runs at 80 r. p. m. and has outlet vane angle of 60^{o}. The velocity of flow is 2.5 m/s throughout and diameter of the impeller at exit is twice that at inlet. If the manometric head is 20 m and the manometric efficiency is 75%,
(I) draw the inlet and outlet velocity diagrams and determine,
(II) The diameter of the impeller at the inlet and exit,
(III) Inlet vane angle at inlet. (10)

4. a) Derive the equation $H=\left(\frac{\pi DN}{60}\right)^2-\left[\frac{\pi DN}{60A}\cot\beta_2\right]Q$, in connection with a centrifugal pump, where the symbols have their usual meanings. Draw the

H *vs.* Q curves (both theoretical and actual) for radial, backward and forward facing blades. Why the actual curves are parabolic in nature? (10)

b) The outer diameter of an impeller of a centrifugal pump is 400 mm and outlet width 50 mm. The pump is running at 1000 r.p.m. and is working against a head of 100 m. The vanes are set back at an angle of 30° and manometric efficiency is 75%. Determine the following:

i) Velocity of flow at outlet,
ii) Angle made by the absolute velocity at outlet with the direction of motion at outlet and
iii) The discharge. (10)

5. a) Draw the sectional views of a Francis turbine and level different components of the same. (10)

b) An inward flow reaction turbine works under a head of 150 m. The inlet and outlet diameters of the runner are 1.5 m and 0.75 m, respectively. The width of the runner is 160 mm, which is constant throughout. The velocity of flow at the outlet is 8 m/s. The blade angle at the outlet is 20°. The hydraulic efficiency is 0.85. Calculate the following:

i) The speed of the Turbine
ii) The inlet blade angle and
iii) The power produced. (10)

6. a) Why draft tube is used in a reaction turbine? With neat sketches explain different types of draft tubes. (10)

b) Calculate the diameter and speed of the runner of a Kaplan turbine developing 6000 kW under an effective head of 5 m. Overall efficiency of the turbine is 90%. The diameter of the boss is 0.4 times the external diameter of the runner. The turbine speed ratio is 2.0 and flow ratio is 0.6. What is the specific speed of the turbine? (10)

7. a) Explain the significance of each term of Reynold's transport equation. (No deduction required). Hence deduce the Euler's turbine head equation clearly explaining the assumptions made. (10)
b) "Degree of reaction of a Pelton turbine is zero." Justify the statement. (3)
c) Obtain an expression for the degree of reaction of a Francis turbine in terms of blade angles. (7)

8. Write Short notes on any two of the following: (2 X 10=20)

1) Specific speed of a Centrifugal Pump and Turbine 2) Priming of a Centrifugal Pump 3) Cavitation in a Turbine 4) Surge tank 6) Different losses of a centrifugal pumps 7) Air Vessel in a reciprocating pump.