EX/ME/T/222/2017

B. M. E. 2nd Year 2nd Semester Examination, 2017

Fluid Machinery-I

Time:-Three Hours Full Marks:-100

Answer Any Five Questions

Assume any data relevant to the questions if not provided

Answer all parts of same question together

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

b) Define the following in connection with a hydraulic turbine:

i) Gross head ii) Net head iii) Hydraulic Efficiency iv) Mechanical Efficiency. (10)

2. a) Give a comparative study between an impulse turbine and a reaction turbine in terms of construction and working principle? What is surge tank and why it is used? (10)

b) Write the Euler equation in connection of a hydraulic turbine and derive the same with clearly narrating the assumptions. (1+9=10)

3. a) An impulse turbine does not require a Draft tube, why? Explain the efficiency of a draft tube. With neat sketch explain different types of draft tube. (1+3+6=10)

b) A Pelton wheel 2.5 m diameter operates under the following conditions:

Net available head, H=250 m

Rotational speed, N=350 r.p.m.

Co-efficient of velocity=0.98

Blade friction coefficient=0.95

Blade angle=165°

Diameter of the jet, d=25 cm

Mechanical Efficiency=95%

Draw the inlet and outlet velocity diagram and determine the following:

i) The power developped ii) Hydraulic Efficiency

iii) Dimensional and non-dimensional specific speed. (10)

4. a) What do you understand by forward, radial and backward facing blades of a centrifugal pump? Draw the theoretical and actual H vs. Q curves for all of them. Explain why the theoretical curves are linear but the actual curves are non-linear. (10)

b) A centrifugal pump running at 800 r.p.m. is working against a total head of 20.2 m. The external diameter of the impeller is 480 mm and outlet width is 60 mm. If the vane angle at outlet is 40° and manometric efficiency is 70%, determine:

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i) Flow velocity at outlet ii) Absolute velocity of water leaving the vane
ii) Angle made by the absolute velocity at outlet with the direction of motion at outlet
iii) Rate of flow through the pump. (10)

5. a) What is cavitation? Where is the probable chance of cavitation in a Francis Turbine? (10)

b) An inward flow reaction turbine has an external diameter and an internal diameter of 1.0 m and 0.5 m, respectively. The hydraulic efficiency of the turbine is 85%, when the head on the turbine is 30 m. The velocity of flow at outlet is 2.0 m/s and the discharge at outlet is radial. If the vane angle at the outlet is 15^{o} and the width of the wheel is 200mm at inlet and outlet, calculate the following:

i) The guide blade angle
ii) Rotational speed of the Turbine
iii) Vane angle of the runner at inlet
iv) Discharge of the turbine
v) Power developed (10)

6. a) Explain why the velocity diagrams at inlet and outlet of a Francis turbine is drawn at different radial positions, but those are drawn at the same radial position for a Kaplan turbine. Also explain why the blades of a Kaplan turbine are twisted. (10)
b) A Kaplan turbine runner is to be designed to develop 9000 kW. The net available head is 5.5 m. Assuming a speed ratio of 2, flow ratio 0.65, and overall efficiency of 85%, the diameter of the boss is 1/3 of the diameter of the runner. Find the diameter of the runner, it's speed and the specific speed of the turbine. (10)

7. a) Explain the working principle of a reciprocating pump. (10)
b) A single acting reciprocating pump has a stroke length of 150 mm, suction pipe is 7 m long and the ratio of suction pipe diameter to the piston diameter is ¾. The water level in the sump is 2.5 m below the axis of the pump cylinder and the pipe connecting the sump and the cylinder is 75 mm in diameter. If the crank is running at 75 r.p.m., determine the pressure head on the piston at the beginning, middle and end of the suction stroke. Take friction coefficient f=0.01. (10)

8. Write Short notes on any four of the following: (4 X 5=20)

1) NPSH
2) Penstock
3) Performance curves and system curve of a Centrifugal pump
4) Wicket gate
5) Thomas Cavitation Parameter