B.E. Mechanical Engineering Fourth Semester
ME405 - Hydraulic Machines

P. Pages : 3

Time : Three Hours

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Max. Marks : 80

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Notes : 1. All questions are compulsory. Solve Q. 1 or Q. 2, Q. 3 or Q. 4, Q. 5 or Q. 6, Q.7 or Q. 8 and Q. 9 or Q. 10.
2. All questions carry marks as indicated.
3. Assume suitable data wherever necessary.
4. Illustrate your answers wherever necessary with the help of neat sketches.
5. Use of non programmable calculator and Drawing instruments.

1. a) Derive the expression for work done by a water jet when it strikes normally series of flat plates mounted on a periphery of a wheel. Also derive the condition for maximum efficiency. **7**

b) A jet of water having a velocity of 35 m/sec impinges on series of vanes moving with a velocity of 20 m/sec. The jet makes an angle of 30º to the direction of motion of vanes when entering and leaves at an angle of 120º.
Draw the velocity triangles and find -
i) the angles of vane tips so that water enters and leaves without shock
ii) Work done/kg of water striking the vanes and
iii) Efficiency **9**

OR

2. a) Give reasons in brief **any three.** **7**

i) Pelton turbines are preferred for heads above 170 m.

ii) Water jet is turned through 160-170º inside the Pelton bucket.

iii) Pelton Bucket's lower portion is cut-off.

iv) Pelton turbines do not employ draft tubes.

b) A Pelton wheel is supplied with 5 m^3/sec when working a under a head of 256 M. Assuming overall efficiency of 85% and coefficient of velocity for nozzle and speed ratio being 0.98 and 0.46 respectively calculate :
i) Shaft Power
ii) Diameter of the wheel and jet diameter
iii) No. of Buckets and its dimensions.
iv) Specific speed
Assume the turbine runs at 500 rpm. **9**

3. a) What is a draft tube ? Discuss its types and function. **7**

b) The following data is available for a Francis turbine : **9**
Net head = 70 m
Speed = 600 rpm
Shaft power = 370 kW
Overall efficiency = 80%
Hydraulic efficiency = 95%
Flow ratio = 0.25
Breadth ratio = 0.1
Outer diameter of runner = 2 x Inner diameter of runner
thickness of vanes occupies 10% of the circumferential area of the runner and if velocity of flow remains constant and water leaves the turbine radially then determine :
i) guide blade angle
ii) runner vane angles at inlet & outlet
iii) runner diameter at inlet and outlet
iv) blade with at inlet & outlet

OR

4. a) What is cavitation ? How can we avoid it at design stage or in operation. **7**

b) A Kaplan turbine runner is to be designed to develop 9000 kW. The net available head is 6m. if the speed ratio is 2.0 and flow ratio is 0.7, over all efficiency 87% and the diameter of boss being 1/3 of the diameter of the runner. Find the diameter of the runner, its speed and specific speed of the turbine. **9**

5. a) What is priming of a centrifugal pump ? Why is it necessary. **6**

b) A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1000 rpm works against a total head of 40 m. **10**
The velocity of flow through the impeller is constant and equal to 2.5 m/sec. The vanes are set back at an angle of 40° at outlet. If the outer diameter of the impeller is 50 cm and the width at the outlet is 5 cm, determine,
i) the vane angle at the inlet
ii) work done / sec by impeller on water
iii) manometric efficiency
Draw the velocity triangles at inlet and exit tips of vane.

OR

6. a) Show that for a centrifugal pump pressure rise inside the impeller can be given by the expression **10**

$$\frac{P_2 - P_1}{w} = \frac{1}{2g}\left[v_{f_1}^2 + u_2^2 - v_{f_2}^2 \cos ec^2\beta_2 \right] \text{ where}$$

v_{f_1} and v_{f_2} are velocities of flow at inlet & outlet tip of vane respectively and u_2 is the peripheral velocity at the outlet tip. β_2 is the blade angle at the outlet tip.

b) Write in short about the following **any two**. **6**

i) Pumps arranged in series and parallel.

ii) N.P.S.H.

iii) Self Priming pumps.

7. a) What do you understand by coefficient of discharge of a reciprocating pump. What is its relationship with ship ? Can ship be negative ? if yes how ? **7**

b) A single acting reciprocating pump has a cylinder of 10 cm diameter and 20 cm stroke. Suction and delivery heads for the pump are 4m and 15 m respectively. Suction pipe has 5 cm diameter and 5 m length while delivery pipe has 4 cm diameter and 20 m length. If separation occurs at 2.4 m of water, find the maximum speed at which pump should be operated without causing separation. **9**

OR

8. a) Explain the working of air vessels fitted on reciprocating pumps in brief. **7**

b) Write in short **any three.** **9**

   i) Gear pumps.

   ii) Vane pumps

   iii) Hand Pumps

   iv) Actual Indicator diagrams.

9. a) Derive the expression for specific speed of a turbine. **7**

b) A turbine model working under a head of 2m runs at 170 rpm and has a diameter of 1m. A prototype turbine develops 22 MW under a head of 250 m with a specific speed of 100. Calculate - **9**
   i) the scale ratio
   ii) power developed by the model.

OR

10. Write short notes **any four.** **16**

   i) Regenerative or peripheral pumps.

   ii) Hydraulic Ram

   iii) Types of similarities.

   iv) Jet pumps

   v) Unit Quantities.

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