Total No. of printed pages = 4

ME 181 PE 11

Roll No. of candidate | | | | | | | | | | |

B.Tech. 7th Semester End-Term Examination

ME

HYDRAULIC MACHINES

(New Regulation w.e.f. 2017-18 & New Syllabus 2018-19)

Full Marks – 70 Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer question No. 1 and any *four* from the rest.

1. Answer the following (Select the correct answer): $(10 \times 1 = 10)$

(i) Cavitation in a hydraulic turbine is most likely to occur at the turbine

(a) Blade inlet (b) Draft tube Exit

(c) Stator exit (d) Rotor exit

(ii) Euler equation for water turbine is derived on the basis of

(a) Rate of change of angular momentum

(b) Conservation of mass

(c) Rate of change of velocity

(d) Rate of change of linear momentum

(iii) Specific speed of a Kaplan turbine ranges between

(a) 300 and 600 (b) 60 and 300

(c) 30 and 60 (d) 600 and 1000

(iv) Kaplanturbine is

(a) An impulse inward flow turbine

(b) An outward flow reaction turbine

(c) A low axial flow turbine

(d) A high head mixed flow turbine

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(v) Two pumps can operate independently at heads H1, H2 and discharge Q1, Q2, respectively. If the pumps are connected in parallel, then what are the resulting discharge (Q) and head (H)?

(a) $Q = Q1 = Q2, H = H1 = H2$

(b) $Q = Q1 + Q2, H = H1 = H2$

(c) $Q = Q1 + Q2, H = H1 + H2$

(d) $Q = Q1 - Q2, H = H1 - H2$

(vi) When the speed of a centrifugal pump is doubled, the power required to drive the pump will:

(a) Increase 4 times (b) Remain the same

(c) Double (d) Increase 8 times

(vii) In a centrifugal pump casing, the flow of water leaving the impeller, is

(a) rectilinear flow (b) radial flow

(c) free vortex motion (d) forced vortex

(viii) Head developed by a centrifugal pump depends on

(a) impeller diameter (b) speed

(c) type of casing (d) both impeller diameter and speed

(ix) Air vessel in reciprocating pump is used to

(a) smoothen flow

(b) reduce acceleration to minimum

(c) increase pump efficiency

(d) save pump from cavitation

(x) Saving of work done and power by fitting an air vessel in a double acting reciprocating pump is of the order of

(a) 39.2 % (b) 49.2 %

(c) 68.8 % (d) 84.8 %

2. (a) A conical type draft tube attached to a Francis turbine has an inlet diameter of 3 m and its area at outlet is 20 m^2. The velocity of water at inlet, which is 5 m above tail race level, is 5 m/s. Assuming the loss in draft tube equals to 50% of velocity head at outlet, find (i) the pressure head at the top of the draft tube (ii) the total head at the top of the draft tube taking tail race level as datum (iii) power lost in draft tube.

(b) The specific speed of an axial flow pump impeller is 1150 and velocity of flow is 2.5 m/s. The outer and inner diameters of the impeller are 0.90m and 0.45 m, respectively. Calculate the suitable speed of the pump to give a head of 5.5 m. Also, calculate vane angle at the entry of the pump.

(c) A radial flow hydraulic turbine produces 32 kW under a head of 16 m and running at 100 rpm. A geometrically similar model producing 42 kW and a head of 6m is to be tested under geometrically similar conditions. If model efficiency is assumed to be 92%, find the diameter ratio between the model and prototype, the volume flow rate through the model, and speed of the model. (5 + 5 + 5 =15)

3. (a) Discuss in general the main and operating characteristics of a centrifugal pump. What is the importance of constant efficiency curves?

(b) A Pelton wheel has a head of 90 m and head lost due to friction in the penstock is 30 m. The main bucket speed is 12 m/s and the nozzle discharge is 1.0 m^3/s. If the bucket has an angle of 15^0 at the outlet and $C_v = 0.98$, find the power of Pelton wheel and hydraulic efficiency. (8 + 7 =15)

4. (a) Define the specific speed of a turbine. Derive an expression for the specific speed.

(b) An inward flow Francis turbine, having an overall efficiency of 86%, hydraulic efficiency of 90%, and radial velocity of flow at inlet 0.28 $\sqrt{2gH}$. The turbine is required to develop 5000 kW when operating under a net head of 30 m, specific speed is 270, assume guide vane angle 30^0, find (i) rpm of the wheel, (ii) the diameter and the width of the runner at inlet, and (iii) the theoretical inlet angle of the runner vanes. (7+8=15)

5. (a) What is priming in centrifugal pump? Obtain an expression for the minimum speed for starting a centrifugal pump.

(b) A centrifugal pump impeller has a diameter of 1.2 m; rpm 210; area at the outer periphery $0.65m^2$; angle of vane at outlet 25^0, and ratio of external to internal diameter 2:1. Calculate (i) the hydraulic efficiency, (ii) power, and (iii) minimum speed to lift water against a head of 6.2 m. Assume that the pump discharges 1550 l/s. (7 + 8 =15)

6. (a) Draw a neat sketch and explain the principle and working of a hydraulic press.

(b) If a hydraulic press has a ram of 12.5 cm diameter and plunger of 1.25 cm diameter, what force would be required on the plunger to raise a mass of 1 tonne on the ram?

(c) A jet of water of diameter 75 mm strikes a curved plate at its centre with a velocity of 25 m/s. The curved plate is moving with a velocity of 10 m/s along the direction of jet. If the jet gets deflected through 165^0 in the smooth vane, compute. (i) Force exerted by the jet (ii) Power of jet (iii) Efficiency of jet. (5 + 3 + 7 =15)

7. (a) What is negative slip in a reciprocating pump? Explain with neat sketch the function of air vessels in a reciprocating pump.

(b) Find the maximum speed of a single acting reciprocating pump to avoid separation, which occurs at 3 m of (abs). The pump has a cylinder diameter 10 cm and a stroke length of 20 cm. The pump draws water from a sump and delivers to a tank. The water level in the sump is 3.5 m below the pump axis and in the tank the water level is 13 m above the pump axis. The diameter and length of the suction pump are 4 cm and 5 m while of delivery pipe the diameter and length are 3cm and 20 m respectively. Take atmospheric pressure head = 10.3 m of water. (8 + 7 =15)