INDIAN MARITIME UNIVERSITY

(A Central University)

B.TECH (MARINE ENGINEERING)

DEC 2014 / JAN 2015 SEMESTER EXAMINATIONS

V SEMESTER

FLUID MACHINES-II (T-1504)

Mechanics - II

Time : 03.00 Hrs
Date:11-12-2014

Max Marks-100
Pass Marks-50

Part-A (3 x 10 = 30 Marks)

QUESTION NO 1 OF PART A IS COMPULSARY

1. a. What do you mean by dimensionless numbers? Name any three dimensionless numbers.
   b. Draw indicator diagram of reciprocating pump and show the combined effect of acceleration and friction on it.
   c. Explain the term 'slip' with reference to reciprocating pump. When can the slip in a reciprocating pump be negative?
   d. Define 'separation' in a reciprocating pump and explain how it can be avoided.
   e. Explain the terms of manometric, mechanical and overall efficiencies of a centrifugal pump.
   f. What is priming of a centrifugal pump? Explain clearly why priming is essential before starting a centrifugal pump.
   g. Why can the suction lift of a pump not exceed a certain limit?
   h. Write a short note on 'draft tube' used in a hydraulic turbine.
   i. How will you classify the turbines?
   j. Define the specific speed of a turbine and also write an expression of specific speed.

Part-B (14 x 5 = 70 Marks)

ANSWER ANY FIVE FROM THE FOLLOWING QUESTIONS

2. a) Two geometrically similar pumps are running at the same speed of 1000 rpm. One pump has an impeller diameter of 0.30 m and lifts water at the rate of 20 litres per second against a head of 15m. Determine the head and impeller diameter of the other pump to deliver half the discharge.

   b) A pelton wheel is revolving at a speed of 190 rpm and develops 5150.25 KW when working under head of 220 m with an overall efficiency of 80 %. Determine unit speed, unit discharge and unit power. The speed ratio for the turbine is given as 0.47. Find the speed, discharge and power when this turbine is working under a head of 140m. (Marks 5+9=14)

2. A single-acting reciprocating pump is to raise a liquid of density 1200 kg per cubic metre through a vertical height of 11.5 m, from 2.5 m below pump axis to 9 m above it. The plunger, which moves with S.H.M., has diameter 125 mm and stroke 225 mm. The suction and delivery pipes are 75 mm diameter and 3.5 m and 13.5 m long respectively. There is a large air vessel placed on the delivery pipe near the pump axis. But there is no air vessel on the suction pipe. If separation takes place at 8.829 N/cm² below atmospheric pressure, find : (i) maximum speed, with which the pump can run without separation taking place, and (ii) power required to drive the pump if f = 0.02. Neglect slip for the pump. (Marks 14)

4. A double acting reciprocating pump has a bore of 0.2 m and stroke of 0.4 m. The suction pipe has a diameter of 0.1 m and is fitted with an air vessel. Find the rate of flow into or from the air vessel when the crank makes angles of 30°, 90° and 120° with inner dead centre. Determine also the crank angles at which there is no flow to or from the air vessel. Take the speed as 120 r.p.m. and assume that the plunger has simple harmonic motion.

5. a) Derive an expression for the starting speed of the centrifugal pump.

   b) The diameter of an impeller of a centrifugal pump at inlet and outlet are 30 cm and 60 cm respectively. Determine the minimum starting speed of the pump if it works against a head of 30 m. (Marks 6+8=14)

6. A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1000 r.p.m. works against a total head of 40 m. The velocity of flow through the impeller is constant and equal to 2.5 m/s. The vanes are set back at an angle of 40 degree at outlet. If the outer diameter of the impeller is 500 mm and width at outlet is 50 mm, determine: (i) Vane angle at inlet (ii) Work done by impeller on water per second, and (iii) Manometric efficiency. (Marks 14)

7. A Francis turbine with an overall efficiency of 75% is required to produce 148.25 kw power. It is working under a head of 7.62 m. The peripheral velocity=$0.26\sqrt{2gH}$ and the radial velocity of flow at inlet is $0.96\sqrt{2gH}$. The wheel runs at 150 r.p.m. and the hydraulic losses in the turbine are 22% of the available energy. Assuming radial discharge, determine: (i) the guide blade angle (ii) the wheel vane angle at inlet (iii) diameter of the wheel at inlet and (iv) width of the wheel at inlet. (Marks 14)

8. A pipeline 1200 m long supplies water to 3 single jet Pelton wheels. The head above the nozzle is 360 m. The velocity coefficient for the nozzle is 0.98 and the friction factor for the pipe line is 0.02. The turbine efficiency based on the head at the nozzle is 0.85. The specific speed of each turbine is 15.3 (in m, kw, r.p.m., units) and the head lost due to friction in the pipeline is 12 m of water. If the operating speed of each turbine is 560 r.p.m., determine: (i) the total power developed (ii) the diameter of each nozzle (iii) the diameter of the pipeline (iv) volume of water used per second. (Marks 14)

9. a) Prove that the hydraulic efficiency of Pelton wheel is maximum when the bucket speed is equal to half the velocity of the jet.

b) An inward flow reaction turbine has external and internal diameters as 1 m and 0.5 m respectively. The velocity of flow through the runner is constant and is equal to 1.5 m/sec. Determine (i) Discharge through the runner and (ii) width of turbine at outlet if the width of the turbine at inlet 200 mm. (Marks 6+8=14)