[Total No. of Questions - 9] [Total No. of Printed Pages - 4]
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B. Tech 5th Semester Examination

Fluid Machines (O.S.)

ME-5003

Time : 3 Hours **Max. Marks : 100**

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : Attempt at least one question from each Section A, B, C & D. Section E is compulsory.

SECTION - A

1. (a) Derive an expression for force exerted and work done for an inclined plate moving in the direction of jet and water jet striking at the centre of the plate. **(8)**

   (b) Water jet at a rate of 10 kg/s striking the series of moving blades at a velocity of 50 m/s. The blades angles with respect to the direction of motion are 35^o and 140^o. If the peripheral speed is 25 m/s, determine the inclination of jet so that water enters the blades without shock. Calculate the power developed and efficiency of the system. Assume blades are mounting on the periphery of wheel. **(12)**

2. (a) Derive an expression for work done and efficiency for water jet striking on the buckets of the pelton wheel. **(8)**

   (b) A Pelton turbine running at 720 rpm uses 300 kg/s of water per second. If the head available is 425 m. Determine the hydraulic efficiency. The buckets deflect the jet by 165^o. Also find the diameter of the runner and jet. Assume C_v=0.97 and ϕ = 0.46, blade velocity coefficient is 0.9. **(12)**

SECTION - B

3. (a) What are various types of draft tubes used for reaction turbines? Give their relative merits & demerits. **(8)**

   (b) In a Francis turbine the guide blade angle is 17^{o} and entry to the runner is in the radial direction. The speed of operation is 400 rpm. The flow velocity remains constant 10 m/s. The inner diameter is 0.6 of the outer diameter. The width at the inlet is 0.12 times the diameter. Neglecting losses, determine the head, the diameter and the power. Also find the angle at the blade outlet. The flow area is blocked by wave thickness by 6%. **(12)**

4. (a) Describe the constructional details of the propeller turbine. Also, describe about the governing mechanism used for such types of turbine units. **(12)**

   (b) Kaplan turbine delivers 30 MW and runs at 175 rpm. The overall efficiency is 91%. The tip diameter is 5m and the hub diameter is 2m. Determine the head and the blade angles at the mid radius. The flow rate is 140 m^3/s. **(8)**

SECTION - C

5. (a) Why does cavitation occur and how it can be checked in fluid machines? **(6)**

   (b) Define the term unit speed, unit power and specific speed as used in connection with operation of hydraulic machines. **(6)**

   (c) A 1/5th scale model of a reaction turbine has an output of 5 HP when tested under a head of 2m and speed of 600 rpm. Make calculations for the speed and power developed by the prototype when working under a head of 8m. **(8)**

6. (a) Explain with neat sketch the construction, operation and utility of the following hydraulic devices:

   (a) Hydraulic Crane (b) Hydraulic ram. **(12)**

(b) An accumulator with 30 cm diameter ram and 6 cm stroke length is loaded with 40 tonnes total weight. The packing friction amounts to 5 percent of load on the accumulator and the ram falls steadily throughout its full range in 120 seconds. During this downward movement of ram at the stated speed, the pump delivers 7.5 litres/s of water to the hydraulic machine. Work out power (total) being delivered to the hydraulic machine. **(8)**

SECTION - D

7. (a) Give typical layout of pumping installation using centrifugal pump, naming main accessories. **(8)**

(b) A pump impeller is 37.5m diameter and it discharges water with velocity components of 2 and 12 m/s in radial and tangential directions. The impeller is surrounded by a concentrical cylindrical chamber with parallel sides, the outer diameter being 45 cm. If the flow in the chamber is free spiral vortex, find the component velocities of water on leaving and the increase in pressure if there is no loss. **(12)**

8. (a) Define the term specific speed of centrifugal pump and deduce an expression for it in terms of head H, the discharge Q and the speed N. **(8)**

(b) A single stage centrifugal pump runs at 500 rpm and delivers 300 m^2/min of water against a head of 120 m. The pump impeller is 2m in diameter and it has a positive suction lift (including the velocity head and friction) of 3m. Laboratory tests are to be conducted on the model with 45 cm impeller and on a reduced head of 95m. Calculate the speed, discharge and suction lift for laboratory tests. Assume vapour head H_v = 0.34m of water and atmospheric head H_a=10.15m of water. **(12)**

[P.T.O.]

SECTION - E

9. (a) What are different basis for drawing performance curves for centrifugal pumps?

(b) What is specific speed? Write expression for specific speed of turbine.

(c) Write three applications of hydraulic ram.

(d) What is degree of reaction in case of hydraulic turbine?

(e) What is impulse-momentum principle?

(f) What are different losses in centrifugal pumps?

(g) What is scale effect?

(h) What is the need of multistaging of centrifugal pumps?

(i) What is working principle of hydraulic lift?

(j) What is function of inlet guide vases in Francis turbines?

(10×2=20)