CBCS SCHEME

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18MR55

Fifth Semester B.E. Degree Examination, Dec.2024/Jan.2025
Turbomachines

Time: 3 hrs. Max. Marks: 100

Note : 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of Steam table and thermodynamic data book permitted.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Differentiate between turbomachines and positive displacement machines. **(04 Marks)**

b. Define Specific speed of a turbine. Derive an expression for the same. **(06 Marks)**

c. A turbine model of 1 : 10 scale develops 2kW under a head of 6m at 500 rpm. Find the power developed by the prototype under a head of 40m. Also find the speed of prototype and its specific speed. Assume turbine efficiency to remain same. **(10 Marks)**

OR

2 a. Show that polytropic efficiency of compression process is given by

$$\eta_p = \left(\frac{\gamma - 1}{\gamma}\right) \times \left(\frac{n}{n-1}\right).$$ **(10 Marks)**

b. A 16 stage axial flow compressor is to have a pressure ratio of 6.3 and tests have shown that a stage efficiency of 89.5% can be obtained. The intake conditions are 288K, 1 bar. Find
i) Overall efficiency ii) Polytropic efficiency iii) Preheat factor. **(10 Marks)**

Module-2

3 a. Derive the alternate from of Euler's turbine equation. Discuss the importance of each term. **(10 Marks)**

b. An inward flow turbine has an inlet angle of 20°, the water leaves radially and speed of the wheel is 350 rpm. Velocity of flow is 4m/s. The inner and outer diameter of the turbine are 30cm and 60cm respectively. Width of the wheel at inlet is 12cm. Find the blade angles and power developed. Also what will be the degree of reaction R? **(10 Marks)**

OR

4 a. Derive the expression for head – discharge (H – Q) characteristics curve for a centrifugal pump. Discuss the H – Q curve for the forward , radial and backward curved vanes. **(10 Marks)**

b. A centrifugal pump delivers water against a head of 25m. The radial velocity of flow is 3.5m/s and it is constant. The flow rate of water is $0.05 m^3/s$. The blades are radial at the tip and pump runs at 1500 rpm. Calculate i) the diameter at the tip ii) the width at the tip and iii) the inlet diffuser angle at its impeller exit. **(10 Marks)**

Module-3

5 a. What is compounding in Turbines? With a neat sketch, explain pressure – velocity compounding. **(10 Marks)**

b. A single row impulse Turbine develops 130kW power at a blade speed of 180m/s using 2 kg steam / second. Steam leaves the nozzle at 400 m/s. Velocity coefficient of blade is 0.9. Steam leaves the blade axially. Determine the nozzle angle, blade angles and diagram efficiency. **(10 Marks)**

OR

6 a. Define degree of reaction for a steam turbine. Show that for a 50% reaction Parson's turbine degree of reaction $R = \frac{V_f}{2u}(\cot \beta_2 - \text{Cot } \beta_1)$. **(10 Marks)**

b. In a 50% reaction turbine, blade tips are inclined at 35° and 20° in the direction of rotor. At a certain place in the turbine diameter of the drum is 1m and 10cm in height, and at this place steam has a pressure of 1.8 bar and dryness fraction of 0.935. If the speed of the turbine is 250 rpm and steam passes through the blade without any shock , find the mass of steam flowing and power developed. Take $V_g = 0.9771\ m^3/kg$ at 1.8 bar. **(10 Marks)**

Module-4

7 a. Show that for a Pelton wheel, the maximum hydraulic efficiency is given by

$$\eta_{max} = \frac{1 + C_b \ \text{Cos}\beta_2}{2}.$$ **(10 Marks)**

b. A Pelton wheel is having a mean diameter of 0.8m and is running at 1000 rpm. The net head on the Pelton wheel is 400m. If the side clearance angle is 15° and discharge through nozzle is 150 liters / second, find i) Power available at the turbine ii) Hydraulic efficiency. **(10 Marks)**

OR

8 a. Explain the functions of a draft tube. Show that pressure at the exit of the reaction turbine with draft tube is less than atmospheric pressure. **(10 Marks)**

b. The internal and external diameter of an inward flow reaction turbine are 1.2m and 0.6m respectively. The head on the turbine is 22m. Velocity of flow through the runner is constant and is equal to 2.5m/s. The guide blade angle is 10° and the runner vanes are radial at inlet. If the discharge at outlet is radial find i) Speed of turbine ii) Vane angle at the outlet iii) Hydraulic efficiency. **(10 Marks)**

Module-5

9 a. Define the following with respect to centrifugal pump :
i) Suction head ii) Delivery head iii) Manometric head iv) manometric efficiency v) Overall efficiency. **(05 Marks)**

b. Explain the phenomenon of cavitation in centrifugal pump. **(05 Marks)**

c. A centrifugal pump delivers 50lts/s of water against a head of 24m ; running at 1500 rpm. The velocity of flow is 2.4 m/s and is constant and the blades are set back at 30°. The inner diameter is half the outer diameter if manometric efficiency is 80%, find the blade angle at inlet and power required to drive the pump. **(10 Marks)**

OR

10 a. Explain i) The need for priming ii) Net Positive Suction Head (NPSH). **(05 Marks)**

b. Derive an expression for minimum starting speed of a centrifugal pump. **(05 Marks)**

c. A three stage centrifugal pump has impeller of 40cm diameter and 2.5cm wide at outlet. The vanes are curved back at 30° and reduce the circumferential area by 15% Manometric efficiency = 88% , Overall efficiency = 75%. Determine the head generated by the pump when running at 1200 rpm and discharge 0.06 m^3/s. Find the power at the shaft of the impeller. **(10 Marks)**

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