CBCS SCHEME

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18ME54

Fifth Semester B.E. Degree Examination, June/July 2023
Turbo Machines

Time: 3 hrs. Max. Marks: 100

Note: **1.** ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of steam tables is permitted.***

Module-1

1 a. Explain the significance and use of :
(i) Flow coefficient (ii) Head coefficient
(iii) Power coefficient (iv) Specific speed of turbomachine **(08 Marks)**

b. A low pressure air compressor develops a pressure of 1.147 bar and temperature of 320 K if the initial pressure and temperature are 1.01 bar and 305 K respectively. Determine compressor and polytropic efficiency. **(06 Marks)**

c. Distinguish static and stagnation properties. Why are stagnation properties preferred to static properties for use in the analysis of turbomachine processes? **(06 Marks)**

OR

2 a. What is a reheat factor? Prove that the overall isentropic expansion efficiency is more than the individual stage isentropic expansion efficiency. **(08 Marks)**

b. Define with the help of temperature entropy diagram for expansion:
(i) Mechanical efficiency (ii) Adiabatic efficiency
(iii) Overall efficiency (iv) Total-Total efficiency **(08 Marks)**

c. A centrifugal pump operating at the best efficiency point produces a head of 26 m and delivers 1 m^3/sec of water when rotating at 1500 rpm. Its impeller diameter is 0.5 m. If a geometrically similar pump of impeller diameter 0.8 m is operating at 1200 rpm, calculate the discharge and head. **(04 Marks)**

Module-2

3 a. Derive an Euler's turbine equation for turbomachine. State the assumptions made in the derivation. **(10 Marks)**

b. A centrifugal pump of 1.5 m diameter runs at 210 rpm and pumps 1.8 m^3/sec of water. The vanes are set back with an angle 25° at exit. Assuming radial entry and velocity of flow throughout is 2.5 m/sec. Determine the power required to drive the pump. If the manometric efficiency of the pump is 65%. Find the average lift of the pump. **(10 Marks)**

OR

4 a. Discuss the effect of discharge blade angle on degree of reaction and energy transfer in the radial flow turbo machine. Assume the radial fluid entry at the inlet. **(10 Marks)**

b. Air enters a rotor in an axial flow turbine with a tangential component of the absolute velocity equal to 600 m/sec in the direction of rotation. At the rotor exit the tangential component of absolute velocity is 100 m/sec in the direction opposite to that of the rotational speed. The tangential blade velocity is 250 m/sec. Evaluate total enthalpy change across the rotor, the change in total temperature across the rotor and the power developed if the mass flow rate is 10 kg/sec. Take the value of C_p = 1.005 kJ/kgK for air. **(10 Marks)**

Module-3

5 a. What are the methods used in reducing the speed of turbine rotor? Explain any one method of reducing speed with necessary sketches. **(10 Marks)**

b. In a reaction turbine, the blade tips are inclined at 35° and 20° in the direction of rotor. The blades are the same shape as the moving blades but reverted in the direction at certain place in the turbine. The drum is 1 m diameter and the blades are 10 cm high of this place the steam has a density of 1.042 kg/m^3. If the speed of the turbine is 250 rpm and the steam passes through the blade without shock find the mass flow rate of the steam and power developed, taking absolute velocity of the steam as 32 m/sec. **(10 Marks)**

OR

6 a. Explain the working of a single stage reaction type steam turbine, with relevant diagrams. **(10 Marks)**

b. Derive an expression for maximum blade efficiency of a single stage impulse turbine with the help of velocity triangles. **(10 Marks)**

Module-4

7 a. Explain with a neat sketch the set up of Kaplan Turbine. Where it is suited? **(10 Marks)**

b. Determine the power given by the jet of water to the runner of a pelton wheel which is having tangential velocity as 20 m/sec. The net head on the turbine is 50 m and discharge through the jet is 0.03 m^3/sec. the side clearance angle is 15° and take $C_V = 0.975$. **(10 Marks)**

OR

8 a. What is a draft tube? Why it is used in reaction turbine? Describe with sketch any two types of draft tube. **(10 Marks)**

b. A Kaplan turbine working under a head of 20 m develops 11772 KW shaft power. The outer and hub diameter of runner is 3.5 m and 1.75 m respectively. The hydraulic and overall efficiency of the turbine are 0.88 and 0.84 respectively. If the velocity of whirl is zero at outlet. Determine: (i) Runner vane angles at inlet and outlet (ii) Speed of the turbine. **(10 Marks)**

Module-5

9 a. With a neat diagram show different heads and efficiencies that are used in the study of centrifugal pumps. **(10 Marks)**

b. The diameter ratio of the impeller of a centrifugal compressor is 2 and the pressure ratio is 4. At a speed of 12000 rpm the flow rate is 10 m^3/sec of free air. The isentropic efficiency of the compressor is 94%. The blades are radial at the outlet and the entry is radial at the inlet. The velocity of flow remains constant at 60 m/sec through the impeller. Calculate:

(i) Power input to the machine

(ii) The impeller diameter at inlet and outlet the suction is from the atmosphere at 100 kPa and 300 K.

Take for air $C_p = 1.004$ kJ/kgK and $\gamma = 1.4$ **(10 Marks)**

OR

10 a. What is slip factor? Explain how does it affect the performance of the centrifugal compressor. **(06 Marks)**

b. Explain what net positive suction head of a centrifugal pump. **(04 Marks)**

c. The blade angles at inlet and outlet of the impeller of a centrifugal pump are 55° and 75° and the corresponding diameters are 3 cm and 6 cm respectively. The blade width at outlet is 0.75 cm. The speed is 1500 rpm. The entry of water is radial without any whirl component. The velocity of flow remains constant in the impeller. Draw the velocity triangles and calculate : (i) Specific work (ii) Flow rate (iii) Power of the machine (iv) The manometric head. The hydraulic efficiency may be taken as 0.85. **(10 Marks)**