CBCS SCHEME

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18ME54

Fifth Semester B.E. Degree Examination, July/August 2021
Turbo Machines

Time: 3 hrs. Max. Marks: 100

Note : 1. ***Answer any FIVE full questions.***
2. ***Use of Steam table and Mollier chart are allowed.***

1 a. With a neat sketch, mention the parts of a Turbo machine. **(04 Marks)**

b. Differentiate Turbo machine with Positive displacement machine. **(06 Marks)**

c. A model of Kaplan turbine one tenth of the actual size is tested under a head of 5m when the actual head for the prototype is 8.5m. The power developed by the prototype turbine is 8000 kW when running at 120 rpm at an overall efficiency of 85%. Determine i) Speed ii) Discharge iii) Power developed iv) Specific speed of the model. **(10 Marks)**

2 a. With the help of h-s diagram, explain the efficiency of power generating type turbo machines. **(08 Marks)**

b. A 16 stage axial flow compressor is to have a pressure ratio of 6.3 and the stage efficiency of 89.5%. The intake conditions are 288K and 1 bar. Determine i) Overall efficiency ii) Polytropic efficiency iii) Preheat factor. **(12 Marks)**

3 a. Define the Degree of Reaction and Utilisation factor. Establish the relationship between them. **(08 Marks)**

b. The velocity of steam outflow from a nozzle in a impulse turbine is 1200 m/s. The nozzle angle being 22^0. If the rotor blades are equiangular and the diameter of runner is 3.5m and rotating with the speed of 2180 rpm. Determine i) Blade angles ii) Tangential force on the blade ring iii) Power output and iv) Utilization factor. Assume $Vr_1 = Vr_2$. **(12 Marks)**

4 a. Show that the degree of reaction for axial flow machine is given by

$$R = \frac{V_f[\tan\beta_1 + \tan\beta_2]}{2u[\tan\beta_1 \times \tan\beta_2]}$$

, where V_f = Velocity of flow. B_1 and β_2 are inlet and outlet blade angles. **(10 Marks)**

b. Show that the degree of reaction for Radial outward flow turbo machine is given by

$$R = \frac{2 + \cot\beta_2}{4}$$

, where β_2 = Blade angle at the exit. **(10 Marks)**

5 a. What do you mean by Compounding of Steam turbine? Explain two methods of Computing. **(08 Marks)**

b. Steam issuing from a nozzle to a De – Laval turbine with a velocity of 1000 m/s. The nozzle angle is 200, the mean blade speed is 400m/s. The blades are symmetrical. The mass flow rate is 1000 kg/hr, Friction factor is 0.8 , Nozzle efficiency = 0.95. Taking the scale of 1:100, find the following Graphically :
i) Blade angles ii) Axial thrust iii) Work done per kg of steam
iv) Power developed v) Blade efficiency vi) Stage efficiency. **(12 Marks)**

6 a. What is Reheating in Steam turbine? List the advantages and disadvantages of reheating. **(08 Marks)**

b. A 20 stage Parson's turbine receiver steam at 15 bar and 300^0C and the steam leaves the turbine at 0.1 bar. The turbine has a stage efficiency of 80% and the reheat factor is 1.06. The total power developed by the turbine is 10658 kW. Find the steam flow rate through the turbine. If the blade exit angle is 25^0, speed ratio is 0.75 and density of steam is 0.59 kg/m^3. Find the mean diameter of the stage and rotor speed. Assume the height of the blade is equal one twelveth of the mean diameter. **(12 Marks)**

7 a. Show that the maximum hydraulic efficiency for a Pelton turbine is given by $\eta_h = \frac{1+K\cos\beta}{2}$, where K = Bladevel coefficient , β = Nozzle angle. **(08 Marks)**

b. A double jet Pelton wheel is required to generate 7500 kW, when the available head at the base of the nozzle is 400m. The jet is deflected through 165^0 and the relative velocity of the jet is reduced by 15%in passing over the buckets. Determine
i) Diameter of jet ii) Total flow iii) Force exerted by the jet in the tangential direction **(12 Marks)**

8 a. Sketch and explain the construction and working of Francis turbine. **(06 Marks)**

b. What is Draft Tube? Explain the types and functions of the draft tubes. **(06 Marks)**

c. A Kaplan turbine working under a head of 15m develops 7350 kW. D_o = 4m , D_h = 2m. The guide blade angle is 30^0. The hydraulic efficiency and overall efficiency of the turbine are 90% and 85% respectively. If the velocity of the Whirl at outlet is zero, find i) Runner Vane angles ii) Speed of the turbine iii) Specific speed of the turbine. **(08 Marks)**

9 a. With reference to Centrifugal pump, define the following :
i) Static head ii) Delivery head iii) Manometric head
iv) Manometric efficiency v) Net Positive suction head. **(08 Marks)**

b. Derive the expression for minimum starting speed of a centrifugal pump. **(06 Marks)**

c. A centrifugal pump with impeller outside diameter of 200mm and rotates at 2900 rpm. The vanes are curved back at 25^0. The velocity of flow is constant at 3m/s. Assuming the hydraulic efficiency at 75% and determine the head generated. Also determine the power required to run the impeller if the breadth of the wheel at the outlet is 15mm. **(06 Marks)**

10 a. Define the Slip and Slip coefficient in Centrifugal Compressor. Also explain the effect of slip in the Centrifugal Compressor. **(06 Marks)**

b. Explain the Surging and Choking in Centrifugal Compressor. **(06 Marks)**

c. A Centrifugal Compressor has an inlet eye 15cm diameter. The impeller revolves at 20000 rpm and the inlet air has an axial velocity of 107 m/s, inlet stagnation temperature and pressure are 294 K and 1.03 bar respectively. Determine
i) Inlet Blade angle ii) Mach number. **(08 Marks)**

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