CBCS SCHEME

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17ME53

Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Turbomachines

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define Turbomachine. With neat sketch, explain the parts of Turbomachine. **(04 Marks)**

b. Define specific speed of pump. Derive an expression for the same in terms of discharge speed and head. **(06 Marks)**

c. A Fransis turbine model is built to scale 1:5 the data for the model is P = 4kW, N = 3500rpm H = 2m and prototype H = 6m. Assume that the overall efficiency of the model as 70%. Calculate: i) Speed of the prototype ii) Power of the prototype. Use Moody's equation. **(10 Marks)**

OR

2 a. Define Polytropic Efficiency of turbine. Show that the Polytropic Efficiency during Expansion process is given by $\eta_p = \dfrac{\ln\frac{T_2}{T_1}}{\frac{\gamma-1}{\gamma}\ln\frac{P_2}{P_1}}$ **(10 Marks)**

b. In a three stage turbine the pressure ratio of each stage is 2 and stage efficiency is 0.75. Calculate overall efficiency and reheat factor. **(10 Marks)**

Module-2

3 a. Derive alternate form of Euler's turbine equation and explain the significance of each energy component. **(10 Marks)**

b. At a 50% reaction stage axial flow turbine the mean blade diameter is 0.6mts. The maximum utilization factor is 0.85 and steam flow rate is 12kg/sec. Calculate the inlet and outlet absolute velocities and power developed if the speed is 2500rpm. **(10 Marks)**

OR

4 a. In a turbomachine prove that the maximum utilization factor is given by

$\in_{max} = \dfrac{2\phi\cos\alpha_1}{1+2\phi R\cos\alpha_1}$ where ϕ = speed ration, R = degree of reaction, α_1 = nozzle angle. **(10 Marks)**

b. Draw the velocity triangles at inlet and outlet of an axial flow compressor from the following data. Degree of reaction 0.5 inlet blade angle 45°. Axial velocity of flow which is constant throughout 120m/sec, speed of rotation 6500rpm, radius of rotation 20cm, blade speed of inlet is equal to blade speed at outlet. Calculate angles at inlet and outlet. Also calculate power needed to handle 1.5kg/s of air. **(10 Marks)**

Module-3

5 a. Why compounding of steam turbine necessary? Describe the velocity compounding of steam turbine with neat sketch. **(08 Marks)**

b. Show that for a two row Curtis steam turbine stage in the absence of friction for axial discharge at exit under maximum utilization condition $U/V_1 = \dfrac{\cos\alpha_1}{4}$ where U = blade speed V_1 = absolute velocity at inlet α_1 = nozzle angle at inlet. **(12 Marks)**

OR

6 a. Define degree of reaction for reaction turbine and derive an expression for the some for 50% reaction turbine. **(10 Marks)**

b. In a Parson's turbine, the axial velocity of flow of steam is 0.5 times the mean blade speed. The outlet angle of the blade is 20° diameter of the blade ring is 1.3m and rotational speed 3000rpm. Determine inlet blade angles, power developed for steam flow of 65kg/sec and isentropic enthalpy drop, if the stage efficiency is 80%. **(10 Marks)**

Module-4

7 a. Show that the specific speed of Pelton wheel is given by $n_s = 206.63\frac{\sqrt{n}}{m}$ where n = number of jets used for the flow, m = wheel diameter to jet diameter ratio. Assume the jet velocity coefficient as 0.97 speed ratio as 0.45 and efficiency of the turbine as 0.89. **(08 Marks)**

b. A double overhung Pelton wheel unit is to produce 30000 kW of a generator under an effective head 300m at the base of the nozzle. Find the size of the jet. Mean diameter of the runner speed and specific speed of each Pelton turbine. Assume generator η = 93% Pelton wheel η = 0.85 speed ratio = 0.46 jet velocity co-coefficient = 0.97 and jet ratio = 12. **(12 Marks)**

OR

8 a. Draw a neat sketch of Francis turbine. Explain the function of draft tube. Also draw the typical velocity triangles of Fransis turbine. **(08 Marks)**

b. A Kaplan turbine working under head of 20m develops 11772kW of shaft power. The outer diameter of the runner is 3.5m and hub diameter is 1.75m. The guide blade angle of the extreme edge of the runner is 35°. The hydraulic and overall efficiencies of the turbine are 88% and 84% respectively. If the velocity of whirl is zero at outlet, determine: i) Runner vane angle at the inlet and outlet at the extreme edge of the runner ii) Speed of turbine. **(12 Marks)**

Module-5

9 a. Show that the pressure rise in the impeller of a centrifugal pump when the frictional and other losses in the impeller are neglected is given by $\Delta p = \frac{\rho}{2}\left[Vf_1^2 + U_2^2 - Vf_2^2 \operatorname{cosec}^2\beta_2\right]$. Vf_1 and Vf_2 are velocity of flow at inlet and outlet of the impeller U_2 = tangential speed of impeller at exit, β_2 = exit blade angle. **(10 Marks)**

b. A centrifugal pump is running at 1000 rpm. The outlet vane angle of the impeller is 45° and the velocity of flow of the outlet is 2.5m/sec. The discharge through the pump is 0.2m^3/sec. When the pump is working against a head of 20m. If the monometric efficiency is 80% draw the outlet velocity diagram and calculate : i) The diameter of the impeller at the outlet ii) width of impeller at the outlet. **(10 Marks)**

OR

10 a. With reference to centrifugal air compressor, explain the following:
i) PreWhirl ii) Surging iii) Slip factor iv) Choking. **(10 Marks)**

b. A centrifugal compressor runs at a speed of 15000rpm and delivers air at 30kg/sec, exit radius is 0.35m, relative velocity and vane angles at exit are 100m/s and 75° respectively. Assuming axial inlet and inlet stagnation temperature and pressure as 300K and 1 bar respectively, calculate: i) Torque ii) The power required to drive compressor iii) The ideal head developed iv) The workdone v) The exit total pressure $(c_p)_{air}$ = 1.005kJ/kgK. **(10 Marks)**

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