CBCS SCHEME

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18MR55

Fifth Semester B.E. Degree Examination, Jan./Feb. 2023
Turbo Machines

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. What is specific speed of Turbine? Obtain an expression for the same in terms of power, speed and head. **(07 Marks)**

b. Different the turbo machine and positive displacement machine. **(05 Marks)**

c. From the performance curves of turbine, it is seen that a turbine of 1m diameter acting under a head of one meter, develops a speed of 25RPM. What diameter should be the prototype have if it is develop 10,000kW working under a head of 200m, with a specific speed of 150. **(08 Marks)**

OR

2 a. Show that polytropic efficiency during the expansion process is given by $\eta_p = \frac{\log_e(T_2/T_1)}{\left(\frac{\gamma-1}{\gamma}\right)\log e\left(P_2/P_1\right)}$. **(08 Marks)**

b. The overall pressure ratio across a three stage gas turbine is 11 and its efficiency is 88%. If the pressure ratio of each stage is the same and the inlet temperature is 1500K, determine: i) Pressure ratio in each stage ii) Polytropic efficiency iii) Stage efficiency iv) Reheat factor v) Exit temperature vi) Total power output if a mass flow rate is 50kgs. Assume for the gas, $C_p = 1.005$kJ/kg K and $\gamma = 1.4$. **(12 Marks)**

Module-2

3 a. Define degree of reaction and utilization factor also show that the relation between them is $\epsilon = \frac{V_1^2 - V_2^2}{V_1^2 - RV_2^2}$. **(10 Marks)**

b. The velocity of steam out flow nozzle in a Delaval turbine is 1200m/s. The nozzle angle being 22°. If the rotor blades are equiangular and the rotor tangential speed is 400m/s, compute:

i) The rotor angles β_1 and β_2
ii) Tangential force on the blade ring
iii) Power output
iv) Utilization factor

Assume $V_{r_1} = V_{r_2}$ **(10 Marks)**

OR

4 a. With usual notations show that the degree of reaction for an axial flow compressor is given by $R = \frac{Va}{2U}(Cot\beta_1 + Cot\beta_2)$. Draw the velocity triangles at inlet and outlet. V_a = Axial flow velocity, U = blade speed, β_1 and β_2 are vane angles at inlet and outlet. **(12 Marks)**

b. A centrifugal pump of 1.5m diameter runs at 210RPM and pumps 1800lits of water per second. The vanes are set back with an angle of 25° at exit. Assuming radial entry and velocity of flow thought is 2.5m/s. Determine the power required to drive the pump. If the manometric efficiency of pump is 65%, find the average lift of the pump. **(08 Marks)**

Module-3

5 a. What is compounding of steam turbines? Explain pressure compounding and velocity compounding. **(09Marks)**

b. Steam flows through the nozzle with a velocity of 450m/s at a direction which is inclined at an angle of 16° to the wheel tangent. Steam comes out of the moving blades with a velocity of 100m/s in the direction of 110°, with the direction of blade motion. The blades are equiangular and steam flow rate is 10kg/s. Find: i) Power developed ii) The power loss due to friction iii) Axial thrust iv) Blade efficiency v) Blade coefficient. **(11 Marks)**

OR

6 a. Show that maximum blade efficiency with equiangular blades for impulse turbine is $\eta_{b\,max} = \cos^2 \alpha_1$. **(12 Marks)**

b. The following data refers to a particular stage of a Parson's reaction turbine. Speed of the turbine is 1500RPM, mean diameter of the rotor = 1m, stage efficiency = 0.8, blade outlet angle = 20°, speed ratio 0.7 determine the available isentropic enthalpy drop. **(08 Marks)**

Module-4

7 a. Derive an expression of maximum hydraulic efficiency for a Pelton wheel turbine. **(10 Marks)**

b. A Pelton wheel producer 15456kW under a head of 335m running at a speed of 500rpm. Turbine overall efficiency = 0.84. Jet velocity coefficient = 0.98, speed ratio = 0.46. If the bucket deflect the incoming jet through an angle of 165°, determine:

i) The number of jets as well as the diameter of the each.

ii) The tangential force exerted by the jets on the buckets. **(10 Marks)**

OR

8 a. Define the following terms with respect to hydraulic turbine.

i) Hydraulic efficiency

ii) Mechanical efficiency

iii) Volumetric efficiency

iv) Overall efficiency. **(08 Marks)**

b. What is draft tube? What are its functions? **(04 Marks)**

c. In a Francis turbine, the discharge is radial. The blade speed at inlet = 25m/s. At the inlet tangential component of velocity = 18m/s. The radial velocity of flow is constant and equal to 2.5m/s. Water flows at the rate of $0.8m^3/s$. The utilization factor is 0.82. Find: i) Euler's head ii) Power developed iii) Inlet blade angle iv) Degree of reaction (R). **(08 Marks)**

Module-5

9 a. Derive an expression for minimum starting speed for a centrifugal pump. **(08 Marks)**

b. Explain the phenomenon of cavitation. **(04 Marks)**

c. A centrifugal pump has its impeller diameter 30cm and a constant area of flow 210cm^2. The pump runs at 1440rpm and delivers 90lps against a head of 25m. If there is no whirl velocity at entry, compute the rise in pressure head across the impeller and hydraulic efficiency of pump. The vanes at exit are bent back 22° with respect to tangential speed. **(08 Marks)**

OR

10 a. Explain following related to centrifugal pump:

i) Pumps in series
ii) Pumps in parallel
iii) Priming
iv) Pre rotation
v) Slip and slip coefficient
vi) Net positive suction head. **(12 Marks)**

b. A 3 stage pump has impeller 40cm in diameter and 2cm width at outlet. The vanes are curved back at angle of 45° with tangential direction and reduced the circumferential area by 10%. The manometric efficiency is 90% and the overall efficiency is 80%. Find the head generated by the pump when running at 1000rpm and delivering 50lit/s. What should be the shaft power? **(08 Marks)**

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