CBCS SCHEME

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15ME53

Fifth Semester B.E. Degree Examination, June/July 2019
Turbo Machines

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. List the difference between positive displacement machine and turbo machine. **(08 Marks)**

b. Two geometrically similar pumps are running at same speed of 1000 rpm. One pump has an impeller diameter of 0.3 m and lifts water at the rate of 20 litres/sec against a head of 15 m. Determine the head and impeller diameter of the other pump to deliver half the discharge. **(08 Marks)**

OR

2 a. Derive the equation of efficiency η_p for compression process

$$\eta_{CS-S} = \frac{(Pr)^{\frac{\gamma-1}{\gamma}} - 1}{(Pr)^{\frac{\in}{\eta_p}} - 1}$$ **(08 Marks)**

b. A turbine has four stages and each stage pressure ratio is 2. The inlet static temperature is 630°C. The mass flow rate is 30 kg/s. the overall efficiency is 0.8. Calculate: (i) the polytropic efficiency (ii) stage efficiency (iii) the power developed (iv) the reheat factor. **(08 Marks)**

Module-2

3 a. Derive the alternate forms of Euler's turbine equation and explain the significance of each energy component. **(08 Marks)**

b. In an axial flow turbine discharge blade angles are 20° each for both stator and rotor. The steam speed at the exit of fixed blade is 150 m/s. The ration $\frac{V_{ax}}{U} = 0.75$ at exit of rotor. Find the inlet blade rotor angle, power developed and degree of reaction for a flow rate of 3.5 kg/s. **(08 Marks)**

OR

4 a. Derive an expression of theoretical head capacity relationship of radial outward flow devices for different values of discharge angles (centrifugal machines). **(08 Marks)**

b. An inward flow reaction turbine has outer and inner diameter wheels as 1 m and 0.5 m respectively. The vanes are radial at inlet and discharge is radial at outlet and fluid enters the vanes at an angle of 10°. Assuming the velocity of flow to be constant and equal to 3 m/s. Find: (i) speed of wheel (ii) vane angle at outlet (iii) degree of reaction. **(08 Marks)**

Module-3

5 a. What is the necessity for compounding steam turbines? Name the different compounding methods and explain any one. **(08 Marks)**

b. In a single stage impulse turbine the mean diameter of the blades is 1m. It runs at 3000 rpm. The steam is supplied from a nozzle at a velocity of 350 m/s and nozzle angle is 20°. The rotor blades are equiangular. The blade friction factor is 0.86. Draw the velocity diagram and calculate the power developed if the axial thrust is 117.72 Newton's. **(08 Marks)**

OR

6 a. For a 50% reaction steam turbine, show that $\alpha_1 = \beta_2$ and $\alpha_2 = \beta_1$, where α_1 and β_1 are the inlet angles of fixed and moving blades, α_2 and β_2 are the outlet blade angles of fixed and moving blade angles. **(08 Marks)**

b. In a reaction turbine, the inlet and outlet blade angles are 50° and 20° respectively. Steam enters at 18° to the plane of the rotor wheel and leaves at 40°. The rotor speed is 260 m/s. Calculate the speed ratio, specific work and degree of reaction. **(08 Marks)**

Module-4

7 a. Show that the maximum hydraulic efficiency of a Pelton wheel turbine is given by $(\eta_h)_{max} = \frac{1+c_b \cos\beta_2}{2}$. Also draw the inlet and exit velocity triangles, c_b is bucket velocity coefficient and β_2 is exit blade angle. **(08 Marks)**

b. The penstock supplies water from a reservoir to the Pelton wheel with a gross head of 500 m. One third of the gross head is lost in friction in the penstock. The rate of flow of water through the nozzle fitted at the end of penstock is 2 m3/s. The angle of deflection of the jet is 165°. Determine the power given by the water to the runner and also hydraulic efficiency of the Pelton wheel. Take speed ratio = 0.45 and $c_v = 1.0$. **(08 Marks)**

OR

8 a. The following data are given for a Francis turbine net head = 70 m, speed = 600 rpm, power at the shaft = 367.5 KW, overall efficiency = 85%, hydraulic efficiency = 95%, flow ratio = 0.25, width ratio = 0.1, outer dia to inner dia ratio = 2. The thickness of the vanes occupy 10% of the circumferential area of the runner. Velocity of flow is constant at inlet and outlet and discharge is radial at outlet. Determine: (i) Guide blade angle (ii) Runner vane angles (iii) Diameter of runner at inlet and outlet (iv) Width of wheel at inlet. **(08 Marks)**

b. With a neat sketch, explain the working of Kaplan turbine. Mention the functions of draft tube. **(08 Marks)**

Module-5

9 a. Explain the following with reference to centrifugal pump:
i) Manometric efficiency with expression
ii) Cavitation in pump
iii) Need of priming
iv) Pumps in series **(08 Marks)**

b. A centrifugal pump is designed to run at 1450 rpm with maximum discharge of 1800 litres/min against a total read of 20 m. The suction and delivery pipes are designed such that they are equal in size of 100 mm. If the inner and outer diameter of the impeller are 12 cm and 24 cm respectively, determine the blade angles β_1 and β_2 for radial entry. Neglect friction and other losses. **(08 Marks)**

OR

10 a. Explain the phenomena of slip factor, surging, stalling and chocking in centrifugal compressor. **(08 Marks)**

b. Air enters a three stage axial flow compressor at 1 bar and 300 K. the energy input is 25 kJ/kg per stage. The stage efficiency is 0.86. Calculate: (i) the exit static temperature (ii) the compressor efficiency (iii) the static pressure ratio. **(08 Marks)**

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