CBCS SCHEME

USN

18MR55

Fifth Semester B.E. Degree Examination, Jan./Feb. 2021

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. Define turbo machine and explain the parts of a turbo machine with a neat sketch. **(06 Marks)**

b. Define the specific speed of a turbine. Obtain an expression for the same in terms of power, speed and head. **(06 Marks)**

c. A one-fourth (1/4) scale turbine model is tested under a head of 10 m. The prototype is required to work under a head of 30 m and to run at 425 rpm. Estimate the speed of the model if it develops 125 kW and uses 1.1 m^3/s of water at this speed. Also calculate the power output of the prototype and suggest the type of turbine. **(08 Marks)**

OR

2 a. Show that polytropic efficiency of compression process is given by, $\eta_P = \left(\frac{r-1}{r}\right) \times \left(\frac{n}{n-1}\right)$. **(10 Marks)**

b. An air compressor has 8 stages of equal pressure ratio of 1.35. The flow rate through the compressor and its overall efficiency are 50 kg/s and 82% respectively. If the condition of air at the entry are 1 bar and 300 K determine (i) stage efficiency (ii) polytropic efficiency (iii) state of air at compressor exit (iv) power required to drive the compressor assuming transmission efficiency of 90%. **(10 Marks)**

Module-2

3 a. Define degree of reaction and show that relationship between utilization factor (ε) and degree of reaction (R) for an axial flow turbine is given by, $\varepsilon = \frac{V_1^2 - V_2^2}{V_1^2 - RV_2^2}$. **(10 Marks)**

b. Air flows axially through an axial flow turbine at a mean radius of 0.3 m. If the tangential component of absolute velocity is reduced by 30 m/s during passage through the rotor, find the power developed for a flow rate of 200 m^3/s at a point where pressure and temperature are 1 bar and 27°C. Speed of the rotor is 3000 rpm. **(10 Marks)**

OR

4 a. With the help of inlet and outlet velocity triangles, show that the degree of reaction for an axial flow compressor, $R = \frac{V_a}{u}\tan\gamma_m$, where V_a is axial velocity, u is blade speed and $\tan\gamma_m = \frac{\tan\gamma_1 + \tan\gamma_2}{2}$. **(10 Marks)**

b. In a mixed flow pump, the absolute fluid velocity at inlet is axial and is equal to radial velocity at exit. Inlet hub diameter = 80 mm and tip diameter = 250 mm, Pump speed = 3000 rpm. Assuming the relative velocity at exit equal to inlet tangential blade speed and fluid leaves the rotor in the radial direction, find (i) Energy transfer (ii) Degree of reaction. **(10 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-3

5 a. Prove that for maximum blading efficiency for a single stage impulse steam turbine is given by $(\eta_b)_{max} = \cos^2 \alpha_1$. **(10 Marks)**

b. Steam at 300 m/s is supplied to a single stage impulse turbine through a nozzle. The nozzle angle is 25°, the mean diameter of the blade rotor is 100 cm and it has a speed of 2000 rpm. Find suitable blade angles, if there is no axial thrust. If the blade velocity coefficient is 0.9 and steam flow rate is 10 kg/s, find the power developed. **(10 Marks)**

OR

6 a. Derive the condition for maximum blade efficiency of 50% reaction turbine (Parson's). **(10 Marks)**

b. At a stage in reaction turbine, the mean blade ring diameter is 1 m and the turbine runs at 50 revolutions per second (RPS). The blades are designed for 50% reaction with exit angle 60° and inlet angle 40° with respect to axial direction. The turbine is supplied with steam at 6,00,000 kg/hr and stage efficiency is 85%. Determine (i) Power output of the stage (ii) Ideal specific enthalpy drop in the stage in kJ/kg (iii) % increases in relative velocity. **(10 Marks)**

Module-4

7 a. Define (i) Hydraulic efficiency (ii) Mechanical efficiency (iii) Overall efficiency for a Pelton wheel. Obtain an expression for the maximum hydraulic efficiency of a Pelton wheel with usual notations. **(10 Marks)**

b. In a power station, a pelton wheel produces 15,500 kW under a head of 350 m, while running at 500 rpm. Assume a turbine overall efficiency of 84%, coefficient of velocity for nozzle as 0.98, speed ratio 0.46 and bucket velocity coefficient 0.86 jet ratio 10. Calculate (i) Number of jets, (ii) Diameter of each jet (iii) Tangential force on the buckets if the bucket deflect the jet through 165°. **(10 Marks)**

OR

8 a. Explain the functions of a draft tube show that pressure at the exit of the reaction turbine with a draft tube is less than atmospheric pressure. **(10 Marks)**

b. A Kaplan turbine working under a head of 4.3 m, produces 10 MW. Taking a speed ratio of 1.8, flow ratio of 0.5, boss diameter 0.35 times the outer diameter, overall efficiency of 90%, find the diameter and speed of the runner. **(10 Marks)**

Module-5

9 a. Define the following for a centrifugal pump with a schematic diagram,
(i) Static head (ii) Suction head (iii) Delivery head (iv) Manometric head **(06 Marks)**

b. Explain Cavitation in pumps. **(04 Marks)**

c. A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1200 rpm works against a total head of 75 m. The velocity of flows through the impeller is constant at 3 m/s. The vanes are set back at an angle of 30° at the outlet. If the outlet diameter of the impeller is 60 cm and width at outlet is 5 cm, determine
(i) Vane angle at inlet. (ii) Workdone /Second by impeller.
(iii) Manometric efficiency. **(10 Marks)**

OR

10 a. Derive an expression for Head capacity (H-Q) characteristics curve for a centrifugal pump. Discuss the H-Q curves for the forward, backward and radial curved blades. **(06 Marks)**

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

c. A centrifugal pump with 1.2 m diameter runs at 200 rpm and pumps 1.88 m^3/s, the average lift being 6 m. The angle which the vane make at the exit with the tangential to the impeller is 26° and the radial velocity of flow is 2.5 m/s. Find the manometric efficiency and the least speed to start the pumping if the inner diameter being 0.6 m. **(08 Marks)**

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