CBCS SCHEME

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15ME53

Fifth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Turbomachines

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Differentiate between turbo machines and positive displacement machines. **(08 Marks)**

b. Test on a turbomachine runner 1.25 m in diameter at 30 m head gave the following results. Power developed = 736 KW. Speed is 180 rpm and discharge 2.7 m^3/s. Find the diameter, speed and discharge of a runner to operate at 45 m head and give 1472 KW at the same efficiency. What is specific speed of both the turbines? **(08 Marks)**

OR

2 a. Show that the polytropic efficiency during the expansion process is given by

$$\eta_p = \frac{\ell n\left[\frac{T_2}{T_1}\right]}{\frac{\gamma-1}{\gamma}\ell n\left[\frac{P_2}{P_1}\right]}.$$ **(08 Marks)**

b. A stream of combustion gases at the point of entry to a turbine has a static temperature of 1050 K, static pressure of 600 kPa, and a velocity of 150 m/s. For the gases, C_p = 1.004 kJ/kgK and γ = 1.41. Find the total temperature and total pressure of the gases. Also find the difference between their static and total enthalpies. **(08 Marks)**

Module-2

3 a. Derive alternate form of Euler equation and explain each component in that. **(08 Marks)**

b. In an inward radial flow hydraulic turbine water enters with an absolute velocity of 15 m/s with a nozzle angle of 15°. The speed of the rotor is 400 rpm. Diameter of the rotor at inlet and outlet are 75 cm and 50 cm respectively. The fluid leaves the rotor radially with an absolute velocity of 5 m/s. Determine: (i) The blade angles (ii) work done (iii) utilization factor. **(08 Marks)**

OR

4 a. Derive theoretical head capacity relation in case of radial flow pump [centrifugal]

$$H = u_2^2 - \frac{u_2^2 Q \cot\beta_2}{A_2}$$

β_2 = discharge blade angle with respect to tangential direction. Explain the effect of discharge angle on it. **(08 Marks)**

b. An axial flow compressor has the following data. Entry conditions: 1 bar and 20°C, degree of reaction = 50%, mean blade ring dia = 60 cm, rotational speed = 18000 rpm, blade angle at rotor and stator exit = 65°. Axial velocity = 180 m/s, mechanical efficiency = 96.7%. Find:

i) Blade angle at rotor and stator inlet.

ii) Power required to derive the compressor. **(08 Marks)**

Module-3

5 a. What is compounding? Explain any two methods of compounding. **(08 Marks)**

b. The following particulars refer to a single impulse turbine. Mean diameter of blade ring = 2.5 m, speed = 3000 rpm, nozzle angle = 20°, ratio of blade velocity to steam = 0.4, blade friction factor = 0.8, blade angle at exit is 3° less than that at inlet. Steam flow rate 36000 kg/hr. Draw the velocity diagram and calculate (i) power developed (ii) blade efficiency. **(08 Marks)**

OR

6 a. Derive the condition for maximum efficiency of reaction steam turbine and hence prove that $\eta_{b\,max} = \frac{2\cos^2\alpha_1}{1+\cos^2\alpha_1}$. **(08 Marks)**

b. A Parson's turbine is running at 1200 rpm. The mean rotor diameter is 1m. Blade outlet angle is 23°, speed ratio is 0.75. Stage efficiency is 0.8. Find enthalpy drop in this stage. **(08 Marks)**

Module-4

7 a. Show that for maximum efficiency of pelton wheel the bucket velocity is equal to half of the jet velocity $U = \frac{V_1}{2}$. **(08 Marks)**

b. In a power station, a pelton wheel producer 15000 KW under a head of 350 m, while running at 500 rpm. Assume a turbine efficiency of 0.84, coefficient of velocity for nozzle as 0.98, speed ratio 0.46 and bucket velocity coefficient 0.86. Calculate: (i) Number of jet (ii) Diameter of each jet (iii) Tangential force on the buckets if the bucket deflect the jet through 165°. **(08 Marks)**

OR

8 a. With a mathematical expression, define the following:

i) Hydraulic efficiency ii) Mechanical efficiency

iii) Overall efficiency iv) Volumetric efficiency **(08 Marks)**

b. A Kaplan turbine working under a head of 20 m develops 11772 KW shaft power. The outer diameter of the runner is 3.5 m and hub dice is 1.75 m. The guide blade angle at the extreme edge of the runner is 35°. The hydraulic and overall efficiency of the turbine are 88% and 84% respectively. If the velocity of whirl is zero at outlet, determine:

i) Runner vane angles at inlet and outlet at the extreme edge of the runner

ii) Speed of the turbine. **(08 Marks)**

Module-5

9 a. Define the following:

i) Suction head ii) Delivery head

iii) Manometric head iv) Net positive suction head **(08 Marks)**

b. A centrifugal pump working in a dock, pumps 1565 ℓ/s, against head (mean lift) of 6.1 m when the impeller rotates at 200 rpm. The impeller diameter is 122 cm and the area at outlet periphery is 6450 cm^2.If the vanes are set back at an angle of 26° at the outlet, find (i) hydraulic efficiency (ii) power required to drive the pump. If the ratio of external to internal diameter is 2, find the minimum speed to start pumping. **(08 Marks)**

OR

10 a. For axial flow compressor show that $E = v_f u\left[\frac{\tan\beta_2 - \tan\beta_1}{\tan\beta_1 \tan\beta_2}\right]$. **(08 Marks)**

b. What are the types of diffuses used in centrifugal compressor? Explain any two. **(08 Marks)**

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