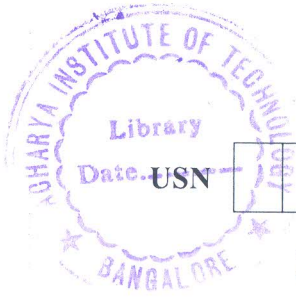


CBCS SCHEME



17ME53

Fifth Semester B.E. Degree Examination, July/August 2021 Turbo Machines

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions.

- 1 a. Summarize the difference between a positive displacement machines and turbomachines. (08 Marks)
b. Test on a turbomachine runner of diameter 1.25m runs at 30m head and gave the following results. Power developed – 736kW, speed of 180rpm with a discharge of 2.7m³/s. Find the diameter, speed and discharge of a runner to operate at 45m head and gives 1472kW at the same efficiency. What is specific speed of both the turbines? (08 Marks)
c. Discuss briefly the effect of Reynold's number on a fluid flow in turbomachines. (04 Marks)
- 2 a. Show that the polytropic efficiency during the process of expansion is given by
$$\eta_p = \frac{\ell_n \left(\frac{T_2}{T_1} \right)}{\frac{\gamma-1}{\gamma} \ell_n \left(\frac{P_2}{P_1} \right)}$$
 (10 Marks)
b. A stream of combustion gases at the point of entry to a turbine has a static temperature of 1050K, static pressure of 600kPa and a velocity of 150m/s. For the gases, C_p-1.004kJ/kg K and γ -1.41. Find the total temperature and total pressure of the gases. Also find the difference between their static and total enthalpies. (10 Marks)
- 3 a. Considering the elements of energy transfer. Derive an alternate form of Euler Turbine equation. (10 Marks)
b. In an axial flow turbine, the discharge blade angles are 20° each, for both the stator and the rotor. The steam speed at the exit of the fixed blade is 140m/s. The ratio of $\frac{V_a}{u} = 0.7$ at the entry and 0.76 at the exit of the rotor blade. Find: i) The inlet rotor blade angle ii) Power developed by the blade ring for a mass flow rate of 2.6kg/sec iii) Degree of reaction. (10 Marks)
- 4 a. Derive theoretical Head-Capacity (H-Q) 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. (10 Marks)
b. An axial flow compressor has the following data entry conditions: 1 bar and 20°C, degree of reaction = 50%, mean blade ring diameter = 60cm, rotational speed = 18000rpm, blade angle at rotor and stator exit = 65°. Axial velocity = 180m/s, mechanical efficiency = 96.7%. Find:
i) Blade angle at rotor and stator inlet
ii) Power required to drive the compressors. (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.

- 5 a. With a neat sketch, explain the pressure-velocity compounding of steam turbine. (10 Marks)
 b. In a Curtis stage with two rows of moving blades the rotor are equiangular. The first rotor has angle of 29° each while second rotor has angle of 32° each. The velocity of steam at the exit nozzle is 530m/s and the blade co-efficients are 0.9 in the first, 0.95 in the stator and in the second rotor. If the absolute velocity at the stage exit should be axial, Find:
 i) Mean blade speed ii) Rotor efficiency iii) Power output for a flow rate of 32kg/sec. (10 Marks)
- 6 a. Derive the condition for maximum efficiency of reaction steam turbine and hence prove that

$$\eta_{b\max} = \frac{2\cos^2\alpha_1}{1 + \cos^2\alpha_1}$$
 (10 Marks)
 b. A Parson's turbine is running at 1200rpm. 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. (10 Marks)
- 7 a. Show that for a Pelton turbine the maximum hydraulic efficiency is given by

$$\eta_{\max} = \frac{1 + C_b \cos\beta_2}{2}$$
 where C_b = blade velocity coefficient, β_2 = Blade discharge angle. (10 Marks)
 b. In a power station, a pelton wheel producer 15000kW under a head of 350m while running at 500rpm. Assume 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° . (10 Marks)
- 8 a. Define the following: i) Monometric Head ii) Hydraulic Efficiency iii) Mechanical Efficiency iv) Overall efficiency v) Volumetric efficiency. (10 Marks)
 b. In a Francis turbine, the discharge is radial, the blade speed at inlet is 25m/s. At the inlet tangential component of velocity is 18m/s. The radial velocity of flow is constant and equal to 2.5m/s. Water flows at the rate of $0.8\text{m}^3/\text{sec}$. The utilization factor is 0.82. Find:
 i) Euler's head ii) Power developed iii) Degree of reaction (R) iv) Inlet blade angle
 Draw the velocity triangles. (10 Marks)
- 9 a. What are the applications of multistage centrifugal pumps? With a neat sketch, explain centrifugal pumps in series and parallel. (10 Marks)
 b. A centrifugal pump working in a dock, pumps 1565l/sec, against head (mean lift) of 6.1m, when the impeller rotates at 200rpm. The impeller diameter is 122cm and the area at outlet periphery is 6450cm^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. (10 Marks)
- 10 a. For axial flow compressor, show that

$$E = V_f u \left[\frac{\tan\beta_2 - \tan\beta_1}{\tan\beta_1 \tan\beta_2} \right]$$
 (10 Marks)
 b. What are the types of diffuser used in centrifugal compressor? Explain any two. (10 Marks)

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