

CBCS SCHEME

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17ME53

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

Time: 3 hrs.

Max. Marks: 100

- Note:** 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of Heat Transfer data handbook is permitted.

Module-1

- 1 a. Define the following for turbomachine:
(i) Specific speed (ii) Flow coefficient
(iii) Energy coefficient (iv) Speed ratio (10 Marks)
- b. An output of 10 KW was recorded on a turbine, 0.5 diameter, revolving at a speed of 800 rpm, under a head of 20 m. What is the diameter and output of another turbine which works under a head of 180 m at a speed of 200 rpm when their efficiencies are same? Find the specific speed and name the turbine can be used. (10 Marks)

OR

- 2 a. Define polytropic efficiency of turbine. Show that the polytropic efficiency during expansion process is given by:

$$\eta_p = \frac{\ell_n \left[\frac{T_2}{T_1} \right]}{\frac{\gamma-1}{\gamma} \ell_n \left[\frac{P_2}{P_1} \right]} \quad (10 \text{ Marks})$$

- b. A nine stage centrifugal compressor has an overall pressure ratio of 2.82. Air enters the compressor at a pressure of 1 bar and 17°C the stage efficiency is 0.9. Determine:
(i) Pre heat factor (ii) Overall efficiency (iii) Polytropic efficiency (10 Marks)

Module-2

- 3 a. Derive an expression for the alternative form of Euler's turbine equation. (10 Marks)
b. Obtain an expression for utilization factor of a turbomachine interms of inlet and outlet absolute velocity of the fluid and degree of reaction. (10 Marks)

OR

- 4 a. Derive an expression for maximum utilization factor for axial flow type of impulse turbine and 50% reaction turbine. (10 Marks)
b. Draw the inlet and outlet triangles for an axial flow compressor for which given :
(i) Degree of reaction = 0.5
(ii) Inlet blade angle = 40°
(iii) Axial velocity of flow which is constant throughout = 125 m/s
(iv) RPM = 6500
(v) Radius 0.2 m

Calculate the power required in KW at an air flow rate of 15 kg/s. Find fluid angles at inlet and outlet. Assume blade speed is same at inlet and outlet. (10 Marks)

Module-3

- 5 a. Name the different compounding methods and explain any one. (10 Marks)
 b. A single stage impulse turbine has a diameter of 1.5 m and running at 3000 rpm. The nozzle angle is 20° , speed ratio is 0.45. Ratio of relative velocity at the outlet to that at inlet is 0.9. The outlet angle of the blade is 3° less than inlet angle. Steam flow rate is 6 kg/s. Draw the velocity triangles and find the following:
 (i) Velocity of whirl (ii) Axial thrust
 (iii) Blade angles (iv) Power developed (10 Marks)

OR

- 6 a. Explain the following:
 (i) Nozzle efficiency (ii) Diagram efficiency
 (iii) Stage efficiency (iv) Axial thrust (10 Marks)
 b. Derive an expression for maximum blade efficiency in an impulse steam turbine. (10 Marks)

Module-4

- 7 a. Show that for maximum utilization the speed ratio is 0.5 for pelton wheel. (10 Marks)
 b. Define the following with reference to hydraulic turbines:
 (i) Overall efficiency (ii) Hydraulic efficiency
 (iii) Mechanical efficiency (iv) Volumetric efficiency (10 Marks)

OR

- 8 a. Draw a neat sketch of Francis turbine. Explain different types of draft tube. Draw typical velocity triangles for Francis turbine. (10 Marks)
 b. A double jet pelton wheel is required to generate 7500 KW under a head of 400 m. The deflection of jet is 165° and the relative velocity of the jet is reduced by 15% in passing over the buckets. Find:
 (i) The diameter of each jet
 (ii) Total flow
 (iii) Force exerted by the jets in the tangential direction.
 Assume generator efficiency is 95%, $\eta_0 = 80\%$, speed ratio = 0.47. (10 Marks)

Module-5

- 9 a. Explain the following with reference to centrifugal pump:
 (i) Manometric efficiency (ii) Cavitation (iii) Need of priming
 (iv) Pumps in series (v) Mechanical efficiency (10 Marks)
 b. Derive an expression of pressure rise in the impeller of centrifugal pump. (10 Marks)

OR

- 10 a. Define the following:
 (i) Pre whirl (ii) Surging (iii) Slip factor (iv) Choking (10 Marks)
 b. An air compressor has eight stages of equal pressure ratio of 1.35. The flow rate and overall efficiency are 50 kg/s and 82% respectively if the conditions of air at entry are 1 bar and 40°C , determine:
 (i) The state of air at the compressor exit
 (ii) Polytropic efficiency
 (iii) Efficiency of each stage (10 Marks)
