Exam Date & Time: 25-Jun-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

Turbomachinery Aerodynamics

TURBOMACHINERY AERODYNAMICS [AAE 4034]

Marks: 50 **Duration: 180 mins.**

Turbomachinery Aerodynamics

Answer all the questions. Section Duration: 180 mins

Answer all Questions

1) Explain the difference between the fan and the compressor. (2)

2) Write different applications of turbomachines (3)

3) A five stage axial flow compressor has an overall stagnation pressure ratio of 3.5:1. The stagnation temperature of air at the compressor inlet is 30^{o}C. The axial flow velocity through the compressor is constant and is 120 m/s. The mean blade speed is 150 m/s. The air enters the compressor with an angle of 5^{o}. The stage efficiency of the compressor is 88%. Determine (i). specific work of the compressor (ii). Rotor blade angles and (iii). Degree of reaction. (5)

4) Draw the velocity triangle of an axial flow compressor. (2)

5) Explain the following terms for an axial flow compressor.

(i) stage loading coefficient

(ii) diffusion factor (4)

6) The speed of an axial compressor is 15000 rpm. The mean diameter is 0.6 m. The axial velocity is constant and is 225 m/s. The velocity of whirl at inlet is 85 m/s. The work done is 45 kJ/kg of air. The inlet conditions are 1 bar and 300 K and stage efficiency is 0.89. Determine the fluid deflection angle and the pressure ratio. (4)

7) Explain the term, power input factor for a centrifugal compressor. (2)

8) Explain different flow track designs for an axial flow compressor. (3)

9) The impeller of a centrifugal compressor has the inlet and outlet diameter of 0.25 m and 0.5 m, respectively. Air enters the compressor without any prewhirl with a stagnation condition of 100 kPa and 300 K. The outlet blade angle is 70^{o}. The speed is 12000 rpm and axial flow velocity is constant at 130 m/s. The isentropic stage efficiency of the compressor is 88%. If the blade width at inlet is 7 cm, determine (i). (5)

Specific work (ii). Stage pressure ratio (iii). Mass flow rate and (iv). Power required to drive the compressor.

10) Explain how the slip factor affects the compressor work. (2)

11) Explain different losses that may occur in a centrifugal compressor. (3)

12) A small axial flow gas turbine with equal stage inlet and outlet velocities has the following data based on the mean diameter. Inlet stagnation temperature = 1200 K, Inlet stagnation pressure = 350 kPa, Axial velocity = 260 m/s, blade speed = 350 m/s, nozzle efflux angle = 60°, stage exit angle = 12°, mass flow rate = 18 kg/s. Determine (i) rotor blade angles (ii) blade loading coefficient (iii) Degree of reaction and (iv) the power output. (5)

13) What do you mean by the impulse turbine stage? (2)

14) Obtain an expression for the degree of reaction of an axial flow turbine. (4)

15) Draw the enthalpy-entropy diagram for radial flow turbine and explain different processes. (4)

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