

MASTER OF MECHANICAL ENGINEERING EXAMINATION, 2018

(1st semester)
TURBOMACHINERY I

Time: 3 hours

Full Marks 100

Answer any four questions.

Q.1

- a) With neat sketches classify different types of turbo-machinery according to the direction of flow through the rotor passage.
- b) Using a control volume for a generalized turbo-machinery, derive the Euler Work Equation
- c) Obtain the expression for Rothalpy and relative stagnation enthalpy.

[8+10+7]

Q.2

- a) With the help of enthalpy-entropy diagram, discuss about various efficiency quantities for a compressor.
- b) An axial flow air compressor is designed to provide overall total-to-total pressure ratio of 8:1. At inlet and outlet the stagnation temperatures are 300 K and 586.4 K, respectively.
Determine the overall total-to-total efficiency and the polytropic efficiency for the compressor. Assume that γ for air is 1.4
- c) Define Design Flow coefficient and Stage Reaction with reference to axial flow turbo-machines

[9+10+6]

Q. 3

- a) Showing the related processes in the h-s diagram, obtain the expression for diffuser efficiency in terms of pressure ratios.
- b) Air enters the diffuser of a compressor with a velocity of 300 m/s at a stagnation pressure of 200 kPa and a stagnation temperature of 200^o C and leaves the diffuser with a velocity of 50 m/s. Using compressible flow relations and assuming the diffuser efficiency, $\eta_D = 0.9$, determine
 - i) The static temperatures at inlet and outlet of the diffuser and the inlet Mach number
 - ii) The static pressure at inlet
 - iii) The increase in entropy caused by the diffuser process.

[12+13]

Q. 4

- a) With the help of a neat sketch, show a typical compressor cascade geometry with the nomenclature.
- b) Show that for a two dimensional incompressible flow through a stationary cascade of compressor blades, the cascade static efficiency is given by

$$\eta = 1 - \frac{2C_D}{C_L \sin 2\alpha_m}$$

- c) Using analysis of cascade forces deduce the expressions for C_L and C_D .

[8+10+7]

Q.5

- a) For a pump derive the expression for specific speed and discuss its significance in design and selection of pumps
- b) Discuss the mechanism of slip in radial flow impeller and derive an expression for it based on Stodola model.
- c) With the help of neat diagram show velocity diagrams at inlet and outlet of a radial flow impeller and explain the relevant quantities

[8+10+7]

Q. 6 Write short notes on any five of the following.

- i) Diffusion geometry
- ii) Co-Ordinate System and flow velocities within a turbo-machines
- iii) Lift coefficient of a fan airfoil
- iv) Different dimensionless terms used in the analysis of incompressible flow turbo-machines.
- v) Reheat factor
- vi) Inherent unsteadiness of the flow within a turbomachine

[5x5]