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 200^0 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]