MASTER OF MECHANICAL ENGINEERING EXAMINATION, 2017

(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 explain small stage or Polytropic efficiency for a compression process and hence show that fir a compression process, the isentropic efficiency is less than the small stage efficiency.

b) Define degree of reaction in a stage for both i) incompressible and reversible flow and ii) compressible and irreversible flow turbo-machine.

c) Discuss about different dimensionless terms used in the analysis of incompressible flow turbo-machines.

[10+8+7]

Q.3

(a) Discuss about radial equilibrium flow and hence deduce the radial flow equilibrium equation for an incompressible fluid in an axial-flow trubo-machine.

(b) The whirl distribution at entry to and exit from a compressor rotor is given by

$C_{\theta 1} = ar - a/r$
$C_{\theta 2} = ar + a/r$
where, a and b are constants.

Verify that, if the axial velocity remains unchanged in passing through the rotor, the degree of reaction is constant at all radii.

[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

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

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

[8+10+7]

Q.5

a) Using blade element theory as used in fan design, establish a relationship connecting pressure rise across the fan and the coefficient of Lift, blade angles and axial velocity component.

(b)Discuss the mechanism of slip in radial flow impeller and derive an expression for it based on Stodola model.

[10+15]

Q. 6

(a) With reference to axial flow turbo-machines. define and explain i) Design flow Coefficient, ii) Stage Loading Coefficient and iii) Stage Reaction

(b) With the help of h-s and velocity diagrams, explain 50% reaction stage

c) Discuss about effect of reaction on efficiency

[10+10+5]

Q.7 Write short notes on any three of the following.

(a) Diffusion within blade row

(b) Co-Ordinate System and flow velocities within a turbo-machines

(c) Lift coefficient of a fan airfoil

(d) Off-Design performance of axial flow compressor

(e) Dimensionless quantities in compressible flow turbo-machines

[3x8]