ME–502

B. E. (Fifth Semester) EXAMINATION, Dec., 2011

(Mechanical Engg. Branch)

TURBO MACHINERY

(ME–502)

Time : Three Hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : Attempt *five* questions in all selecting *one* question from each Unit. All questions carry equal marks. Assume suitable missing/misprint data if any.

Unit–I

1. (a) Define turbomachine and classify them on the basis of fluid movement through the machine. 5

   (b) Air flows through an air turbine where its stagnation pressure is decreased in the ratio 5 : 1. The total to total efficiency is 5 kg/s. If the total power output is 500 kW, find : 15

   (i) Inlet total temperature.

   (ii) Actual exit total temperature.

   (iii) Actual exit static temperature if the flow velocity is 100 m/sec.

   (iv) The total to static efficiency of the device.

P. T. O.

Or

2. (a) Define the following for a turbomachine : 8

   (i) Specific speed

   (ii) Stage efficiency

   (iii) Overall efficiency

   (iv) Degree of reaction

   (b) In a gas turbine, the gas enters at the rate of 5 kg/s with a velocity of 50 m/sec. and enthalpy of 900 kJ/kg and leaves the turbine with a velocity of 150 m/sec. and enthalpy of 400 kJ/kg. The loss of heat from the gases to the surroundings is 25 kJ/kg. Assume for gas $R = 0{\cdot}285$ kJ/kgK and $C_p = 1{\cdot}004$ kJ/kg°K and inlet conditions to be at 100 kPa and 27°C. Determine the power output of the turbine and the diameter of the inlet pipe. 12

Unit–II

3. In an impulse turbine with single row of wheel, the mean diameter of the blade is 1·05 m and the speed is 3000 r. p. m. The nozzle angle is 20° and the ratio of blade speed to steam speed is 0·45 and the relative velocity and outlet from the blades to that at inlet is 0·85. The outlet angle is made 3° less than the inlet angle. The steam flow is 10 kg/sec. Draw the velocity diagram for the blade and determine the following : 20

   (i) Tangential thrust on the blades

   (ii) Axial thrust on the blade

   (iii) Resultant thrust on the blades

   (iv) Power developed in the blades

   (v) Blading efficiency

Or

4. The following data refers to a reaction turbine :
   Speed = 3000 r. p. m.

Power developed = 1 MW
Rotor speed = 225 m/s
Nozzle angle = 20°
Steam speed = 350 m/sec.
Specific volme of steam at nozzle inlet = 4·5 m^3/kg
Specific volme of steam at nozzle exit = 5 m^3/kg
Blade height = 0·15 m
Carry over efficiency = 0·9
Nozzle efficiency = 0·93.
Calculate : 20

(i) Enthalpy drop in each stage
(ii) The degree of reaction
(iii) The stage efficiency

Unit – III

5. (a) What is the purpose of draft tube. List any *two* types of draft tubes with neat sketch. 5

(b) A radially inward flow reaction turbine working under a head of 9 m and running at 200 r. p. m. develops 175 kW. The speed ratio and flow ratio are 0·9 and 0·3 respectively. Find : 15

(i) the inner diameter of the runner
(ii) the width of wheel at inlet
(iii) the guide blade angle at the inlet
(iv) the inlet vane angle

Or

6. Show that the discharge of a centrifugal pump is given by : 20

$$Q = ND^3 \phi \left[\frac{gH}{N^2 D^2} \Big/ \frac{\mu}{ND^2 \rho} \right]$$

where :
N = the speed of the pump in r. p. m.

D = the diameter of the impeller
g = the acceleration due to gravity
H = the manometric head
μ = viscosity of fluid
ρ = density of fluid

Unit – IV

7. (a) What are the advantages and disadvantages of centrifugal compressors ? 6

(b) A centrifugal blower takes air at 100 kPa and 309°K. It develops a pressure head of 750 mm W. G., while consuming a power of 33 kW. If the blower efficiency in 79% and mechanical efficiency is 83%, determine the mass rate and volume rate and exit properties of air. 14

Or

8. An axial compressor stage has the following data. Stagnation temp. and pressure at entry are 20°C and 1 bar and the degree of reaction is 50%. 20

Flow coefficient ϕ	$= 0{\cdot}5$
Mean blade ring diameter	$= d_m = 35$ cm
Speed N	= 18000 r. p. m.
Air angles at rotor and stator exit	$= \alpha_1 = \beta_2 = 60°$
Blade height at entry	$= h = 5$ cm
Work done factor	$= \phi = 0{\cdot}88$
Isentropic efficiency	$= \eta_{d-1} = 0{\cdot}85$
Mechanical efficiency	$= \eta_m = 0{\cdot}96$

Calculate :

(i) The air angles at the rotor and stator entry.
(ii) The mass flow rate of air.

(iii) The power required to drive the compressor.

(iv) The loading coefficient.

(v) Pressure ratio developed by the stage.

(vi) Mach number at rotor entry.

Unit – V

9. (a) What is a hydraulic coupling ? Explain with a neat sketch, the working of a hydraulic coupling. 12

(b) In a fluid coupling, speeds of the driving and driven shafts are 800 r. p. m. and 780 r. p. m. respectively. Find : 8

(i) efficiency of the coupling.

(ii) the slip of the coupling.

Or

10. (a) What is a torque converter ? Explain the working principle of convertor with the help of a neat sketch. 8

(b) Differentiate between turbomachine and positive displacement machine. 6

(c) Find out the efficiency and slip of a fluid coupling if the speeds of the driving and driven shafts are 700 and 650 r. p. m. respectively. 6