

CRASH COURSE

USN

--	--	--	--	--	--	--	--	--	--

10ME/MR56

Fifth Semester B.E. Degree Examination, May 2017

Turbo Machines

Time: 3 hrs.

Max. Marks:100

Note: Answer any FIVE full questions, selecting atleast TWO questions from each part.

PART – A

1. a. What is a Turbomachine? Give the classification of turbo machines. (06 Marks)
b. Define specific speed of a turbine, derive an expression for the same in terms of power, speed and head. (06 Marks)
c. A Pelton turbine produces 5000 KW under a head of 250m and has speed of 210 rpm. Overall efficiency of turbine is 85%. Find the unit quantities. If the head falls to 160m what are the new values of speed, discharge and power? Find also the specific speed of the turbine. (08 Marks)
2. a. Discuss static and stagnation state for a fluid. (04 Marks)
b. With T – S (or) h-s diagram deduce an expression for poly tropic (or) Infinitesimal stage efficiency for the process of compression. (08 Marks)
c. Air flows through an air turbine where its stagnation pressure is reduced in the ratio of 5:1. Total – to – total efficiency is 80% , airflow rate is 5kg/s. If the total power output is 500KW, find i) Inlet total temperature ii) Actual exit total temperature iii) Actual exit static temperature if the flow velocity is 100m/s iv) Total – to – static efficiency. (08 Marks)
3. a. With necessary velocity triangles derive the alternate form of Euler’s turbine equation and discuss the importance of each term. (10 Marks)
b. The internal and external diameters of the impeller of a centrifugal pump are 200mm and 400mm respectively. Pump is running at 1200 rpm. The vane angle of impeller at inlet is 20° . Water enters the impeller radially and the velocity of flow is constant. Calculate the work done by the impeller per kg of water for the following three cases :
i) $\beta_2 = 30^\circ$ ii) $\beta_2 = 90^\circ$ and iii) $\beta_2 = 100^\circ$. (10 Marks)
4. a. With necessary velocity triangles and assumptions discuss the effect of Blade discharge angle on energy transfer and Degree of reaction for the case of radial flow machines. (10 Marks)
b. The velocity of steam outflow from a nozzle in a DeLaval turbine is 1200 m/s, nozzle angle being 22° . If the rotor blades are equiangular and the rotor tangential speed is 400 m/s, compute i) rotor angles β_1 and β_2 ii) The tangential force on the blade ring and iii) Power output, assuming $V_{t1} = V_{t2}$. Find also the utilization factor. (10 Marks)

PART – B

5. a. With necessary velocity triangles derive the maximum blade efficiency equation for velocity compounded impulse turbine or Curtis turbine. (10 Marks)

- b. The following data refers to a Curtis turbine having two rows of moving blades and a fixed row in between them. Velocity of steam leaving the nozzles 1200m/s , nozzle angle $- 20^\circ$, Blade speed $- 250\text{m/s}$, Blade angles of first moving blades are symmetrical. Blade outlet angle of the fixed blade is 25° , Blade outlet angle of the second moving row is 30° , Friction factor for all the rows is 0.9. Draw the velocity diagram and calculate the power developed, axial thrust on the shaft for a steam flow rate of 5000 kg/hr . (10 Marks)
- 6 a. Derive an expression for the work done by Pelton wheel with necessary velocity diagrams. (06 Marks)
- b. Discuss the following with regard to hydraulic turbines :
i) Hydraulic efficiency ii) Volumetric efficiency iii) Mechanical efficiency
iv) Overall efficiency. (08 Marks)
- c. Estimate the main dimensions for a Francis turbine to suit the following conditions :
Head 100m , Power 2.5 MW , Speed 500 rpm , Hydraulic efficiency 0.9 , Overall efficiency 0.85 , Flow ratio 0.15 , Ratio of wheel width to wheel diameter at inlet 0.1 . Outer diameter twice the inner diameter and velocity of flow is constant. (06 Marks)
- 7 a. List and discuss the following related to centrifugal pump :
i) Heads of a centrifugal pump ii) Efficiencies of a centrifugal pump. (10 Marks)
- b. Determine the inlet vane angle, discharge, manometric head , shaft power and torque of a centrifugal pump from the following data. Hub and tip diameters are 100mm and 200mm , outlet width 12.5mm , vane angle at outer tip is 25° , speed 2900 rpm , constant velocity of flow is 3 m/s , manometric efficiency 78% and overall efficiency 72% . (10 Marks)
- 8 a. Explain the following with regard to centrifugal compressor :
i) Power input factor ii) Pressure coefficient iii) Surging. (06 Marks)
- b. A centrifugal compressor running at 5950 rpm having impeller tip diameter 1000mm . Mass flow rate is 30kgs . Static pressure ratio 2.125 . Pressure at the inlet is 1atm and temperature is 25°C . Slip factor $\mu = 0.9$ and mechanical efficiency 0.97 . Determine
i) Total - to - total efficiency ii) Temperature of air at exit iii) Power input needed and iv) Pressure coefficient. (08 Marks)
- c. Derive an expression for workdone , efficiency and overall pressure ratio for an axial flow compressor. (06 Marks)
