CRASH COURSE

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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 20^0. 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) $\beta_2 = 30^0$ ii) $\beta_2 = 90^0$ and iii) $\beta_2 = 100^0$. **(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 22^0. 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 $V_{r_1} = V_{r_2}$. 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 – 20^0 , Blade speed – 250m/s , Blade angles of first moving blades are symmetrical. Blade outlet angle of the fixed blade is 25^0 , Blade outlet angle of the second moving row is 30^0 , 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 25^0 , 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 25^0C. 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)**

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