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10ME56

Fifth Semester B.E. Degree Examination, Jan./Feb. 2023
Turbomachines

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Define Turbomachines. Explain the effect of Reynolds number on it. **(06 Marks)**

b. Define Unit quantities in turbomachines and obtain expression for them. **(08 Marks)**

c. A turbine is to operate under a head of 30 meters at 300 rpm. The discharge is $12m^3/S$. If the efficiency is 85%, determine the performance of the turbine under a head of 50 meters. **(06 Marks)**

2 a. Obtain the relation between stage efficiency and overall efficiency for expansion process and compare them. **(12 Marks)**

b. Define Polytropic efficiency and stage efficiency for a compression and expansion process. **(08 Marks)**

3 a. Obtain Alternate form of Euler – turbine equation with velocity triangle. **(06 Marks)**

b. Calculate the absolute velocities and power developed for a 50% reaction stage axial turbine if the mean blade diameter is 60cm. The maximum utilization factor is 90% and steam flow rate is 10kg/s. **(08 Marks)**

c. Write the velocity triangle for the following cases with conditions :
   i) Blades are radial at inlet and discharge is radial at outlet for a turbine.
   ii) Discharge is Axial at inlet and blades are radial at outlet. **(06 Marks)**

4 a. In an inward flow radial hydraulic turbine , degree of reaction is 'R' and utilization factor '$\in$'. If the velocity of flow is constant and non whirl component at outlet, show that the inlet Nozzle angle 'α_1', is given by

$$\alpha_1 = \cot^{-1}\sqrt{\frac{(1-R)}{(1-\in)}}\in.$$ **(10 Marks)**

b. Show that $U/V_1 = 2/3 \cos\alpha_1$ for an axial flow turbine with maximum utilization for a degree of reaction $R = 1/4$. Where U = Blade speed ;

V_1 = Absolute velocity of H_2O at inlet ; α_1 = Guide blade angle at inlet. **(10 Marks)**

PART – B

5 a. Prove that for a Parson's reaction turbine velocity triangles are symmetrical when the degree of reaction is 50%. **(10 Marks)**

b. In a single stage impulse turbine , the diameter of the blade ring is 1 meter and speed is 3000 rpm. The steam is issued from a nozzle at 300m/s and the nozzle angle is 20°. The blades are equiangular. If the loss of relative velocity at outlet is 19% to that of inlet. Find the power developed in the blading when the Axial thrust on the blades is 90N. **(10 Marks)**

6 a. A Kaplan turbine is to be designed to develop 8000 kW of Sp. The net available head is 10 meters. If speed ratio = 1.8 , Flow ratio = 0.6 , Overall efficiency = 70% and the ratio of diameter of runner to diameter of boss is 2.5. Find the diameter of runner, speed and specific speed. **(10 Marks)**

b. Obtain an expression for power given to runner and hydraulic efficiency in Pelton wheel. **(10 Marks)**

7 a. Explain Manometric head in centrifugal pump with equations. **(06 Marks)**

b. With usual notations, obtain an expression for pressure rise in an impeller of a centrifugal pump. **(10 Marks)**

c. Find the number of pump required to take water from a deep well under a total head of 100 meters. All pumps are identical and are running at 1000 rpm. The specific speed of each pump is 30 and the rated capacity of each pump is $0.2 m^3/s$. **(04 Marks)**

8 a. Obtain an expression for pressure ratio in a centrifugal compressor. **(10 Marks)**

b. Air at a temperature of 290K flows in a centrifugal compressor running at 20000 rpm. Slip factor = 0.8 , Isentropic efficiency = 0.75 , Outer diameter of blade tip = 500mm. Assume absolute velocities are same. Calculate
i) Temperature rise of air in compressor ii) The static pressure ratio.
Take C_p = 1.0035 kJ/kg K. **(10 Marks)**

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