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10ME56

Fifth Semester B.E. Degree Examination, June/July 2017

Turbo Machines

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. ***Missing data may be assumed suitably.***

PART – A

1 a. List the difference between positive displacement machines and turbo machines. **(05 Marks)**

b. Explain the significance of flow coefficient, head coefficient and power coefficient with equations. **(05 Marks)**

c. An output of 10 KW was recorded on a turbine of 0.5 m dia running at a speed of 800 rpm under a head of 20 m. What is the diameter and output of another turbine which works under a head of 180 m, at a speed of 200 rpm when their efficiencies are same? Find the specific speed and name the turbine which you preferred. **(10 Marks)**

2 a. Define static and stagnation states. **(05 Marks)**

b. Define total-to-total efficiency and static to static efficiency of compression process. **(05 Marks)**

c. Air enters a compressor at a static pressure of 1.5 bar, a static temperature of 15°C and a flow velocity of 50 m/s. At the exit the static pressure is 3 bar, the static temperature is 100°C and the flow velocity is 100 m/s. The outlet is 1 m above the inlet. Evaluate:
i) The isentropic change in enthalpy
ii) The actual change in enthalpy
iii) Efficiency of compressor. **(10 Marks)**

3 a. With a neat sketch derive an expression for Euler's turbine equation. **(10 Marks)**

b. An inward flow reaction turbine has outer and inner diameter of the wheel as 1 m and 0.5 m respectively. The vanes are radial at inlet, and the discharge is radial at outlet and water enters the blade at an angle of 10°. Assume the velocity of flow is constant and equal to 3 m/s, find:
i) Speed of the wheel
ii) Outlet blade angle
iii) Degree of reaction R. **(10 Marks)**

4 a. Derive an expression for degree of reaction for radial outward flow machine and explain briefly the effect of β_2, blade discharge angle on degree of reaction 'R'. **(10 Marks)**

b. For a radial outward flow turbo machine has no inlet whirl. The blade speed at the exit is twice that of inlet. Assume radial velocity is constant, with inlet blade angle = 45°. Show that degree of reaction,

$$R = \frac{2 + \cot\beta_2}{4}$$

where β_2, blade angle at exit with respect to tangential direction. **(10 Marks)**

PART – B

5 a. Derive the condition for maximum utilization factor for impulse turbine. **(10 Marks)**

b. The following data refers to Delaval turbine. Velocity of steam at exit of the nozzle is 1000 m/s with a nozzle angle of 20°. The blade velocity is 400 m/s and the blades are equiangular. Assume a mass flow rate of 1000 kg/hr, friction coefficient 0.8 nozzle efficiency 0.95. calculate:

i) Blade angles
ii) Work done/kg of steam
iii) Power developed
iv) Blade efficiency
v) Stage efficiency. **(10 Marks)**

6 a. Define the draft tubes with a neat sketch. Explain different type of draft tubes. **(05 Marks)**

b. Define mechanism efficiency and overall efficiency of turbines. **(05 Marks)**

c. A propeller turbine has a outer diameter of 4.5 m and inner diameter 2m. It develops 20,605 KW under a head of 20 m at 137 rpm, the hydraulic efficiency is 0.94 overall efficiency is 0.88. Find the:

i) Runner blade angles
ii) Discharge through the runner. **(10 Marks)**

7 a. Explain with a neat sketch, multistage centrifugal pump arrangement. **(05 Marks)**

b. Explain with a neat sketch, different casings of pump. **(05 Marks)**

c. A three stage centrifugal pump has impeller 40 cm dia and 2 cm width at outlet. The vanes are curved back at an angle of 45° at the outlet and reduced the circumferential area by 10%. The manometric efficiency is 90% and overall efficiency is 0.8. Find the total head generated by the pump, when running at 1000 rpm, delivering 50 lit/sec. also calculate the power required to drive the pump. **(10 Marks)**

8 a. Explain slip and slip coefficient. **(05 Marks)**

b. Explain surging and choking of compressor. **(05 Marks)**

c. An axial flow compressor of 50% reaction design has blades with inlet and outlet angles with respect to axial directions of 45° and 10° respectively. The compressor is to produce a pressure ratio of 6:1 with a overall isentropic efficiency of 0.85. When the inlet static temperature is 37°C. The blade speed and axial velocity are constant throughout the compressor. Assuming a value of 200 m/s for blade speed. Find the number of stages required if the work done factor is (i) unity, (ii) 0.87 for all the stages. **(10 Marks)**

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