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10ME56

Fifth Semester B.E. Degree Examination, Aug./Sept.2020

**Turbo Machines**

Time: 3 hrs.

Max. Marks:100

- Note:** 1. Answer any FIVE full questions, selecting at least TWO questions from each part.  
2. Use of thermodynamic data hand book is permitted.

**PART - A**

- 1 a. Differentiate between a turbomachines and positive displacement machines. (04 Marks)  
b. Define specific speed of a turbine. Derive an expression for specific speed of a turbine from fundamentals. (06 Marks)  
c. Tests on a turbine runner 1.25 m in diameter at 30 m head gave the following results:  
(i) Power developed = 736 KWatts  
(ii) Speed = 180 rpm  
(iii) Discharge = 2.70 m<sup>3</sup>/sec  
Find the diameter, speed and discharge of runner to operate at 45 m head and give 1472KWatts at the same efficiency. What is the specific speed of the both the turbines? (10 Marks)
- 2 a. Define:  
(i) Total-to-total efficiency  
(ii) Total static efficiency for power absorbing turbomachines with H-S diagram (06 Marks)  
b. Show that Reheat Factor in multi stage turbine is greater than unity along with H-S diagram. (06 Marks)  
c. A gas turbine has the following data. Inlet pressure and temperature 5 bar and 500K, exit pressure is 1.2 bar overall turbine efficiency is 0.90. Mass flow rate of the gas is 20 kg/sec. Determine the polytropic efficiency of expansion. Take  $C_p = 1.005$  kJ/kgK and  $r = 1.4$ . (08 Marks)
- 3 a. Define Degree of Reaction. Explain the components of degree of reaction. (05 Marks)  
b. Obtain the expression for maximum utilization factor in 50% reaction turbine. (07 Marks)  
c. At a 50% reaction stage axial flow, turbine, the mean blade diameter is 60 cm. The maximum utilization factor is 0.9. Steam flow rate is 10 kg/sec. Calculate the inlet and outlet velocities and power developed if the speed is 2000 rpm. (08 Marks)
- 4 a. Sketch and explain radial flow turbomachine with inlet and outlet velocity triangles and show that the degree of reaction  $R = \frac{2 + \cos \beta^2}{4}$ . (10 Marks)  
b. A turbine with 50% reaction the tangential blade speed is 98.5 m/sec. The steam velocity at the nozzle exit is 155 m/sec and the nozzle angle is 18°. Assuming symmetric inlet and outlet velocity triangles. Compute the inlet blade angle for the rotor and the power developed by the stage for a flow rate of 10 kg/sec. Also find the utilization factor. (10 Marks)

**PART - B**

- 5 a. What is compounding? Explain briefly a two-stage pressure compounding impulse turbine and show the velocity and pressure variations across the turbine. (10 Marks)

- b. In a stage impulse turbine, the steam velocity at nozzle mouth is 300 m/sec. The nozzle angle  $18^\circ$  and blade velocity is 144 m/sec. Draw to a suitable scale the diagram of relative velocities for the steam assuming that the outlet blade angle is  $3^\circ$  less than inlet angle. Take blade velocity coefficient as 0.86. If the power to be developed is 1000 KWatts. Calculate the mass of steam that passes through the turbine/sec. (10 Marks)
- 6 a. Derive an equation for maximum efficiency condition of impulse type hydraulic turbine
- $$\eta_{\max} = \frac{1 + \cos \beta_2}{2} . \quad (10 \text{ Marks})$$
- b. A Kaplan turbine working under a head of 15 m develops 7350 KW power. The outer diameter of runner is 4m and hub diameter is 2m. The guide blade angle at the extreme edge of the runner is  $30^\circ$ . The hydraulic and overall efficiency of the turbine are 90% and 85% respectively. If the velocity of whirl is zero at outlet, determine:
- Runner vane angle at inlet and outlet at the extreme edge of the runner
  - Speed of the turbine
- (10 Marks)
- 7 a. Define the following terms for a centrifugal pumps:
- Net positive suction head
  - Manometric efficiency
  - Mechanical efficiency
- (06 Marks)
- b. Derive an expression for a minimum starting speed for a centrifugal pump. (06 Marks)
- c. The outer diameter of the impeller of a centrifugal pump is 40 cm and the width of the impeller at outlet is 5 cm. The pump is running at 800 rpm and working against a total head of 15 m. The vane angle at outlet is  $40^\circ$  and manometric efficiency is 75%. Determine:
- Velocity of flow at outlet
  - Velocity of water leaving the vane
  - Angle made by the absolute velocity at outlet
  - Discharge of pump
- (08 Marks)
- 8 a. What is the function of diffuser? Name different types of diffusers used in centrifugal compressor and explain them with simple sketches. (10 Marks)
- b. Air enters a compressor at a static pressure of 1.5 bar, a static temperature of  $15^\circ\text{C}$  and a flow velocity of 15 m/sec. At the exit the static pressure is 3 bar. The static temperature is  $100^\circ\text{C}$  and the flow velocity is 100 m/sec. The outlet is 1m above the inlet. Evaluate:
- The isentropic change of enthalpy
  - The actual change in enthalpy
  - Efficiency of the compressor
- (10 Marks)

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