

USN

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

10ME56

CMRIT LIBRARY  
BANGALORE - 560 037

Fifth Semester B.E. Degree Examination, June/July 2018

**Turbo Machines**

Time: 3 hrs.

Max. Marks:100

**Note: 1. Answer FIVE full questions, selecting at least TWO full questions from each part.**

**2. Use of steam tables and thermodynamic data handbook is permitted.**

**PART – A**

- 1 a. Define a turbomachine. Explain with neat sketch construction and working of a turbomachine. (06 Marks)
  - b. Enumerate the difference between a turbomachine and a positive displacement machine. (06 Marks)
  - c. A wind mill model of 1:10 scale develops 2 kW under a head of 6m at 500rpm. A prototype work under a head of 40m. Assuming that the efficiencies of model and prototype remains same. Determine the power developed, speed of the prototype and its specific speed. (08 Marks)
  - 2 a. Define the following with the help of h-s diagram for the power generating turbomachines:
    - i) total-to-total efficiency ii) total-to static efficiency. (04 Marks)
  - b. Derive an expression for an overall isentropic efficiency for a finite number of stages of compression in terms of pressure ratio, stage efficiency, number of stages and ratio of specific heats for a compressor. (08 Marks)
  - c. A 16 stage axial flow compressor is to have a pressure ratio of 6.3 with a stage efficiency of 89.5%. The intake conditions are 15°C and 1 bar. Determine:
    - i) Expected overall efficiency
    - ii) The polytropic efficiency
- Take  $\gamma = \frac{C_p}{C_v} = 1.4$ . (08 Marks)
- 3 a. Define utilization factor and degree of reaction of a turbine. Derive an expression for establishing relation between utilization factor and degree of reaction. (10 Marks)
  - b. An impulse turbine having mean blade diameter 0.75m runs with a speed of 2800 rpm. The absolute velocity of jet leaving a nozzle inclined at 18° to the plane of wheel is 280 m/s. If the utilization factor is 0.88 and relative velocity at the rotor exit and at the inlet remains same. Determine:
    - i) The inlet and outlet blade angles
    - ii) Work done
    - iii) Power output for a mass flow rate of 10 kg/s. (10 Marks)
  - 4 a. Explain why turbine with reaction  $R > 1$  and  $R < 0$  are not in practical use? (04 Marks)
  - b. In an inward flow radial hydraulic turbine for maximum utilization factor show that,

$$\alpha_1 = \cot^{-1} \sqrt{\frac{(1-R)}{1-\epsilon}} \quad \text{where } \alpha_1 = \text{Nozzle angle, } R = \text{Degree of reaction, } \epsilon = \text{utilization}$$

factor. Assume radial velocity component is constant throughout and there is no tangential component of absolute velocity at outlet. (08 Marks)

1 of 2

CMRIT LIBRARY  
BANGALORE - 560 037

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and/or equations written eg. 42+8=50, will be treated as malpractice.

- c. Air enters in an axial flow turbine with a tangential component of absolute velocity equal to 600 m/s in the direction of rotation. At the rotor exit, the tangential component of absolute velocity is 100m/s in a direction opposite to that of rotational speed. The tangential blade speed is 250m/s. Find:
- Change in total enthalpy of air between the inlet and outlet of the rotor.
  - The power developed if the mass flow rate is 10kg/s
  - The change in total temperature across the rotor.
- (08 Marks)

**PART – B**

- 5 a. What are the differences between impulse and reaction steam turbine. (06 Marks)
- b. Explain with the help of a neat sketch how an impulse steam turbine is compounded for velocity. (06 Marks)
- c. In a stage of an impulse turbine provided with single row wheel, the mean diameter of blade is 1m rotates at 3000rpm. Steam issues from a nozzle at a velocity of 350 m/s and nozzle angle  $20^\circ$ . The rotor blades are equiangular, blade friction is 0.86. Determine the power developed if the axial thrust acting on the rotor bearing is 120N. (08 Marks)
- 6 a. Derive an expression for maximum hydraulic efficiency of a Pelton wheel in terms of runner tip angle and bucket velocity coefficient. (10 Marks)
- b. A Pelton wheel develops 23.11 MW under a head of 1770m while running at 750rpm. Find:  
i) Jet diameter ii) Mean diameter of the runner iii) Number of buckets.  
Assume:  $C_v = 0.97$ ,  $\phi = 0.46$ ,  $\eta_T = 0.85$ . (10 Marks)
- 7 a. Explain the following with reference to centrifugal pumps:  
i) Manometric efficiency with expression.  
ii) Cavitation in pumps  
iii) Net positive suction head  
iv) Need for priming  
v) Pumps in series. (10 Marks)
- b. A centrifugal pump delivers 50 litres against a total head of 24m when running at 1500rpm. The velocity of flow is maintained constant at 2.4 m/s and blades are curved back at  $30^\circ$  to the tangent at outlet. The inner diameter is half the outer diameter. If the manometric efficiency is 80%, determine:  
i) Blade angle at inlet  
ii) Power required to drive the pump. (10 Marks)
- 8 a. What is the function of a diffuser? Name the different types of diffusers and explain them with neat sketch. (10 Marks)
- b. A centrifugal compressor delivers 20kg/s of air with a total head pressure ratio of 4:1. The speed of the compressor is 12,000rpm. Inlet total temperature is  $15^\circ\text{C}$  stagnation pressure at inlet is 1.0 bar, slip factor is 0.9, power input factor is 1.04. Efficiency is 80%. Calculate the outer diameter of the impeller. (10 Marks)

\*\*\*\*\*