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10ME56

**Fifth Semester B.E. Degree Examination, Dec.2016/Jan.2017**  
**Turbo Machines**

Time: 3 hrs.

Max. Marks:100

**Note: 1. Answer FIVE full questions, selecting at least TWO questions from each part.**  
**2. Assume missing data, if any.**

**PART – A**

- 1 a. Differentiate between a positive displacement machine and a turbomachine. (05 Marks)  
b. Define specific speed of a turbine. Derive an expression for specific speed of a pump. (08 Marks)  
c. Tests on a turbine runner 1.25 m in diameter at 30 m head gave the following results:  
Power developed 736 KW speed 180 rpm, Discharge 2.7 m<sup>3</sup>/s  
Find the diameter, speed and discharge of a runner to operate at 45 m head and give 1472 kW power at the same efficiency. What is the specific speed of both the turbines? (07 Marks)
- 2 a. For a compression process, show that the isentropic efficiency is given by,  
$$\eta_c = \frac{P_r^{\frac{\gamma-1}{\gamma}} - 1}{P_r^{\gamma_{np}} - 1}$$
 (08 Marks)  
b. Define the following for a compression process :  
(i) Total to total efficiency (ii) Static to static efficiency (04 Marks)  
c. A 16 stage axial flow compressor is to have a pressure ratio of 6.3 and tests have shown that a stage efficiency of 89.5% can be obtained. The intake conditions are 288 K and 1 bar pressure. Find  
(i) Overall efficiency (ii) Polytropic efficiency (iii) Preheat factor (08 Marks)
- 3 a. Define degree of reaction (R). Derive an expression relating utilization factor with degree of reaction. (10 Marks)  
b. Water approaches the impeller of a mixed flow pump with an absolute velocity having tangential and axial components each of 17 m/s. At the rotor exit the radial and tangential components of the absolute velocity are 13 m/s and 25 m/s respectively. The tangential blade speed at inlet and exit are 12 m/s and 47 m/s. Find  
(i) Change in enthalpy across the rotor.  
(ii) Total change in pressure across the rotor.  
(iii) Change in static pressure.  
(iv) Degree of reaction. (10 Marks)
- 4 a. The internal and external diameters of the impeller of a centrifugal pump are 20 cm and 40 cm respectively. The pump is running at 1200 rpm. The Vane angle of impeller at inlet is 20°. The water enters the impeller radially and velocity of flow is constant. Calculate workdone by the impeller / kg of water for the following two cases:  
(i) When vane angle at outlet is 90°.  
(ii) When Vane angle at outlet is 100°  
Draw the corresponding velocity triangles. (10 Marks)  
b. Derive head-capacity relationship for centrifugal pumps and explain the effect of discharge angle on it. (10 Marks)

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.

**PART – B**

- 5 a. Write a note on compounding of steam turbines and explain any two types of compounding with neat sketches. (10 Marks)
- b. A simple impulse turbine has a mean blade speed of 200 m/s. The nozzles are inclined at  $20^\circ$  to the plane of rotation of the blades. The steam velocity from nozzles is 600 m/s. The turbine uses 3500 kg/hr of steam. The absolute velocity at exit is along the axis of turbine. Determine
- Inlet and exit angles of blades.
  - Power output of turbine.
  - Diagram efficiency. (10 Marks)
- 6 a. With a neat sketch, explain the working of Kaplan turbine. Mention the functions of draft tube. (10 Marks)
- b. The penstock supplies water from a reservoir to the Pelton wheel with a gross head of 500 m. One third of the gross head is lost in friction in the penstock. The rate of flow of water through the nozzle fitted at the end of penstock is  $2 \text{ m}^3/\text{s}$ . The angle of deflection of the jet is  $165^\circ$ . Determine the power given by the water to the runner and also hydraulic efficiency of the Pelton wheel. Take speed ratio 0.45 and  $C_v$  1.0 (10 Marks)
- 7 a. Derive an expression for minimum starting speed of a centrifugal pump. (06 Marks)
- b. Define the following with respect to centrifugal pumps:
- Manometric head
  - Manometric efficiency
  - Overall efficiency. (06 Marks)
- c. A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1000 rpm works against a total head of 40 m. The velocity of flow through the impeller is constant and equal to 2.5 m/s. The vanes are set back at an angle of  $40^\circ$  at outlet. If the outer diameter of the impeller is 500 mm and width at outlet is 50 mm, determine
- Vane angle at inlet
  - Workdone by impeller on water/s
  - Manometric efficiency. (08 Marks)
- 8 a. Explain the phenomenon of surging and stalling in centrifugal compressors. (06 Marks)
- b. With a neat sketch, explain the parts of a axial flow compressor. (06 Marks)
- c. An axial flow compressor has the following data entry condition 1 bar,  $20^\circ\text{C}$  degree of reaction 50% mean blade ring diameter 36 cm, Rotational speed 18000 rpm blade height at entry 6 cm, Blade angle at rotor and stator exit  $65^\circ$  axial velocity 180 m/s mechanical efficiency 0.967.
- Find
- Guide blade angle at outlet.
  - Power required to drive the compressor. (08 Marks)

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