Printed Pages : 4

EME-309

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 121308

Roll No.

B. Tech.

(SEM. III) (ODD SEM.) THEORY EXAMINATION, 2014-15

THERMAL AND HYDRAULIC MACHINES

Time : 3 Hours] [Total Marks : 100

Note : (1) Attempt all questions.
(2) Steam tables and Mollier charts may be used.

1 Attempt any **FOUR** parts of the following : **(4×5=20)**

(a) What do you mean by quasi-static process ? How do state functions differ from path functions? Give examples of each.

(b) What do you understand by thermodynamic equilibrium? Explain.

(c) State the various statements of Second law of Thermodynamics with examples.

(d) Explain the Carnot cycle and derive an expression for its efficiency.

(e) 1 kg of steam at 10 bar, 200°C is mixed adiabatically with 2 kg of steam at 10 bar, 0.8 dry. Determine the net change in entropy during the mixing process.

(f) Prove that Rankine Efficiency is lower than the Carnot Efficiency.

2 Attempt any **TWO** parts of the following : **(2×10=20)**

(a) In a gas turbine cycle, air at 27°C and 0.98 bar is compressed to 6 bar. The temperature of air is increased to 750°C as it passes through the combustion chamber. The isentropic efficiencies of compressor and turbine are 0.8 and 0.85 respectively. Determine the thermal efficiency of the plant.

(b) Prove that for a 50 % reaction turbine, the inlet and exit angles of moving and fixed blade are equal.

(c) Steam at a velocity of 400 m/s relative to the moving blades enters an impulse turbine at an angle of 30°. The blade velocity is 250 m/s. The work developed in the blade is estimated to be 165.54 kJ/kg. Assuming the blades to be symmetrical in shape determine the blade efficiency and blade velocity coefficient.

3 Attempt any **TWO** parts of the following : **(2×10=20)**

(a) A two stage, single acting air compressor takes an air at 1 bar, 300 K. Air is discharged at 10 bar. The intermediate pressure is optimum and intercooling is perfect. The index of compression is 1.3 in both the stages. If the mass flow rate of air is 0.1 kg/s through the machine, determine :

(I) Power required to derive the compressor.

(II) Heat rejected in the intercooler.

(b) Discuss the importance of volumetric efficiency and isothermal efficiency of air compressor .What are the method used to improve theses efficiencies?

(c) Show that the efficiency of an air standard Otto cycle is a function of compression ratio only.

4 Attempt any **TWO** parts of the following : **(2×10=20)**

(a) A jet of water having a velocity of 40 m/s impinges on a series of vanes moving with a velocity of 15 m/s.The jet makes an angle of 30° to the direction of motion of vane when entering and leaves at an angle of 120°. Draw the velocity triangles at inlet and outlet and determines:

(I) The angles of vanes tips so that water enters and leaves without shock

(II) The efficiency.

(b) A three jet Pelton turbine is required to generate 8000 kW under a head of 400 m. The buckets deflect the jet through an angle of 165°.The decrease in the relative velocity while passing over the blade is 5%.The overall efficiency of the turbine is 80%.Determine the diameter of the jet and the force exerted by a jet on the buckets. Assume coefficient of velocity as 0.98 and the ratio of vane velocity to jet velocity is 0.46.

(c) A reaction turbine operating under a head of 70 m runs at 400 rpm. Its diameter at inlet is 1m and the flow area is 0.35 m^2. The angles made by absolute and relative velocity at inlet are 15° and 45° respectively, with the tangential velocity. For radial discharge at outlet, find the volume flow rate and the hydraulic efficiency.

5 Attempt any **TWO** parts of the following : **(2×10=20)**

(a) With the help of a neat sketch, explain in brief the functioning of volute casing of a centrifugal pump.

(b) A double acting reciprocating pump, running at 45 rpm, is discharging 0.009 m^3/s of water. The pump has a stroke of 40 cm. The diameter of the piston is 20 cm.The suction and delivery heads are 3 m and 14 m, respectively. Find the slip of the pump and power required to drive the pump. Neglect the effect of piston rod area.

(c) What do you mean by cavitation? Define Thoma's cavitation factor. Discuss the effects of cavitation on performance of pumps.
