Printed Pages—4 **EME309**

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

PAPER ID : 0207 **Roll No.** | | | | | | | | | | |

B.Tech.

(SEM. III) ODD SEMESTER THEORY EXAMINATION 2012-13

THERMAL AND HYDRAULIC MACHINES

Time : 3 Hours *Total Marks : 100*

Note : *(1) Attempt* ***all*** *questions and be precise in your answers.*

(2) Use of steam table and Mollier chart is permitted.

(3) Universal gas constant, R = 8.3143 kJ/kg K. For air C_p = 1.005 kJ/kg K, Molecular weight = 29.

(4) Assume suitably any missing data.

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

(a) Answer the following :

(i) 5 m^3 of air is contained in rigid vessel at 50 °C and 500 kPa. A wax candle is burning in the centre of a vessel. After one hour the final pressure in the vessel is 1 MPa. Find the change in internal energy, change in entropy of air and mass of wax combusted in one hour. Assume calorific value of wax as 36 MJ/kg and neglect the change in volume of air due to wax combustion.

(ii) State the Kelvin-Plank and Clausius statement and show their equivalence.

(b) Answer the following : **(4+6=10)**

(i) Draw schematic diagram and T-s chart of reheat Rankine cycles. When reheating is needed in steam power plant ?

(ii) In a steam turbine plant running on ideal Rankine cycle, steam leaves the boiler at 10 MPa and 700 °C and comes out as saturated water from condenser at 0.05 bar. For the 50 MW output of the plant, determine (i) thermal efficiency of plant (ii) heat rejected and change in internal energy in condenser (iii) temperature of steam at the inlet to the condenser.

(c) Answer the following :

(i) A closed vessel contained 1.5 kg of saturated steam at 5 bar pressure. Find the quantity of heat which must be rejected so as to reduce the pressure of steam to 3 bar. Also find the final temperature and quality of steam.

(ii) Draw Carnot cycle on P-v and T-s chart. How you determine the feasibility, reversibility and irreversibility of a process ?

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

(a) Answer the following :

(i) Why compounding is done in steam turbine ? Show the variation of pressure and velocity along the axis of pressure compounded steam turbine.

(ii) Prove that the optimum pressure ratio for maximum specific output for a gas turbine plant is given by, $r_p = (T_3/T_1)^{\gamma/2(\gamma-1)}$, where T_3 and T_1 is maximum and minimum temperature.

(b) Steam flows from the nozzles of a single row impulse turbine with a velocity of 450 m/s at a direction which

is inclined at an angle of 16° to the peripheral velocity. Steam comes out of the moving blades with a velocity of 100 m/s at an angle of 110° with the direction of the blade motion. The blades are equiangular. Steam flow rate is 8 kg/sec. Find the blade angles, power developed and power loss due to friction.

(c) Air at 1 bar and 15 °C enters a gas turbine plant working at pressure ratio of 5. Turbine inlet temperature is 800 °C. Isentropic efficiency of turbine and compressor is 0.85, calorific value of fuel used is 42 MJ/kg. Find efficiency, specific output, A/F ratio and specific fuel consumption.

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

(a) Answer the following :

(i) Explain the working of four stroke diesel engine with neat sketch.

(ii) Compare the Otto and Diesel cycle for same maximum pressure and temperature with the help of p-V and T-s diagram.

(b) Derive an expression for the volumetric efficiency of a single stage reciprocating compressor. State the conditions which lower the volumetric efficiency.

(c) Explain phenomenon of surging and choking in compressors.

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

(a) Show that in case of jet striking the flat plates mounted on the wheel, the efficiency will be maximum, when the tangential velocity of wheel is half that of the jet.

(b) A Pelton wheel is supplied with water under a head of 30 m at a rate of 41 m^3/min. The jet strikes the buckets in centre of bucket, and it is deflected through an angle of 160°. The mean bucket speed is 12 m/s. Calculate the power and hydraulic efficiency of the machine.

(c) (i) Describe the points of difference between impulse and reaction turbines.

(ii) Draw a general layout of a hydroelectric power plant with reaction turbine and explain hydraulic, mechanical and overall efficiencies.

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

(a) Sketch and state the difference between volute casing, vortex casing and diffuser type casing of a centrifugal pump.

(b) A centrifugal pump running at 1450 rpm discharges 100 liters/sec of water against a head of 23 metres. If the diameter of impeller is 250 mm and its width is 50 mm, find the vane angle at outer periphery. Assume manometric efficiency of pump as 75%.

(c) Draw a theoretical indicator diagram of a reciprocating pump and derive relationship for work and power input.