Reg. No. :

Question Paper Code : 90356

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/ DECEMBER 2019

Third/Fourth Semester

Mechanical Engineering

ME 8391 – ENGINEERING THERMODYNAMICS

(Common to Automobile Engineering/Industrial Engineering/Mechanical and Automation Engineering/Plastic Technology)

(Regulations 2017)

Time : Three Hours

Maximum : 100 Marks

Use of Steam table/Mollier chart/Psychrometric chart allowed.

Answer ALL questions.

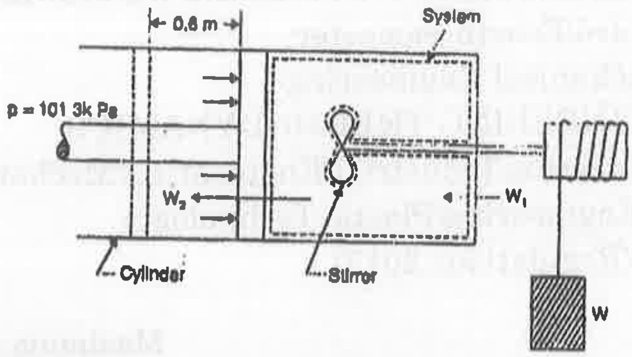
PART – A (10×2=20 Marks)

1. Differentiate between closed system and open system.
2. State Zeroth law of thermodynamics.
3. What is the function of refrigerator ? How is its COP defined ?
4. Why does the entropy of actual universe always increase ?
5. What is the latent heat of evaporation ?
6. Why does Rankine cycle have lower efficiency compared to Carnot cycle ?
7. When does real gas behave like ideal gas and why ?
8. List various thermodynamic potentials used for deriving Maxwell's relations.
9. State Amagat's law of partial volumes.
10. What is the effect of adiabatic saturation process ?

PART – B (5×13=65 Marks)

11. a) i) State first law of thermodynamics and specify its applications. (3+2)

ii) A piston and cylinder machine containing a fluid system has a stirring device as shown in Fig.



The piston is frictionless, and it is held down against the fluid due to atmospheric pressure of 101.3 kPa. The stirring device is turned 9500 revolutions with an average torque against the fluid of 1.25 Nm. Meanwhile the piston of 0.65 m diameter moves out 0.6 m. Find the network transfer for the system. (8)

(OR)

b) i) Prove that for a steady flow system with negligible change in kinetic and potential energy, the shaft work per kg can be expressed as $W_s = -\int v dp$ (5)

ii) A working substance flows at a rate of 5 kg/s into a steady flow system at 6 bar 2000 kJ/kg internal energy and 0.4 m^3/kg specific volume with a velocity of 300 m/s. It leaves at 10 bar,1600 kJ/kg of internal energy, 1.2 m^3/kg of specific volume with a velocity of 150 m/s. The inlet is 10 m above the outlet. The work transfer to the surroundings is 3 MW. Evaluate the change in enthalpy and estimate the heat transfer and indicate the direction. (8)

12. a) Draw the Carnot cycle on p-V and T-s Diagram to derive its efficiency and explain the major inference from Carnot cycle efficiency. (3+3+4+3)

(OR)

b) Two Carnot engines work in series between the source and sink temperatures of 550 K and 350 K. If both engines develop equal power, draw the schematic and label them properly and also determine the intermediate temperature. (3+2+8)

13. a) Draw the p-v-T surface for a normal substance and explain the formation of the superheated steam from ice at constant pressure. (8+5)

(OR)

b) A pressure cooker contains 1.5 kg of saturated steam at 5 bar. Find the quantity of heat which must be rejected so as to reduce the quality to 60% dry. Determine the pressure and temperature of the steam at the new state. (7+3+3)

14. a) Describe the use of reduced properties, principle of corresponding states and compressibility chart. (3+6+4)

(OR)

b) Derive the TdS relation in terms of T and V and hence deduce the expression for change in the internal energy per unit change in volume at constant temperature. (8+5)

15. a) i) State Dalton's law and prove the same. (5)

ii) The exhaust gas of an internal combustion engine is found to have 9.8% CO_2, 0.3% CO, 10.6% H_2O, 4.5% O_2 and 74.8% N_2 by volume. Calculate molar mass and gas constant of the exhaust gas. If the volume flow rate of exhaust gas is $2m^3/h$ at 100 kPa and 573 K, calculate its mass flow rate. (8)

(OR)

b) i) Describe the adiabatic Mixing of Air Streams. (5)

ii) An air-water vapour mixture enters an air-conditioning unit at a pressure of 1.0 bar 38°C DBT, and a relative humidity of 75%. The mass of dry air entering is 1 kg/s. The air-vapour mixture leaves the air-conditioning unit at 1.0 bar, 18° C, 85% relative humidity. The moisture condensed leaves at 18°C. Determine the heat transfer rate for the process. (8)

PART – C (1×15=15 Marks)

16. a) A Carnot heat engine works between two temperature of source at 900 K and sink at 300 K. It operates a Carnot refrigerator working between two temperatures of 300 K and 250 K. The heat engine is supplied with 50 kJ/s and it not only operates refrigerator, but also delivers a net power of 10 kW. i) Determine the heat transferred to the refrigerant in the refrigerator and the net heat transfer to the sink maintained at 300 K. ii) Recalculate the above, if the actual efficiency of the heat engine is 50% of the maximum value and COP of the refrigerator is 50% of the maximum value. (8+7)

(OR)

b) In a power station, the saturated steam is generated at 200°C by transferring the heat from hot gases in a steam boiler. The gases are cooled from 1000°C to 500°C and all the heat from gases goes to water. Assume water enters the boiler at saturated condition and leaves as saturated steam. i) Calculate the mass of gas required to produce a kg of steam and ii) Find the increase in total entropy of the combined system of gas and water and increase in unavailable energy due to irreversible heat transfer. Take C_p (for gas) = 1.0 kJ/kg.K, h_{fg} (latent heat of steam at 200°C) = 1940.7 kJ/kg. (8+4+3)