Reg. No. : [ ]

Question Paper Code : 20851

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2022.

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 approved thermodynamic tables, Mollier diagram, Psychometric chart and Refrigerant property tables are permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define zeroth law of thermodynamics.

2. What is a quasi-static process?

3. What do you mean by 'Clausius inequality'?

4. A turbine gets a supply of 5 kg/s of steam at 7 bar, 250° C and discharges it at 1 bar. Calculate the availability.

5. Draw a P-T (Pressure- temperature) diagram for a pure substance.

6. Define Dryness fraction.

7. Define Joule- Thomson Coefficient.

8. Define 'Equations of state'?

9. Define 'Dalton's law of partial pressure.

10. What is meant by adiabatic saturation temperature?

PART B — ($5 \times 13 = 65$ marks)

11\. (a) A cylinder contains 1 kg of a certain fluid at an initial pressure of 20 bar. The fluid is allowed to expand reversibly behind a piston according to a law pv^2 = Constant until the volume is doubled. The fluid is then cooled reversibly at constant pressure until the piston regains its original position; heat is then supplied reversibly with the piston firmly locked in position until the pressure rises to the original value of 20 bar. Calculate the net work done by the fluid, for an initial volume of 0.05 m^3.

Or

(b) A system contains 0.15 m^3 of a gas at a pressure of 3.8 bar and 150°C. It is expanded adiabatically till the pressure falls to 1 bar. The gas is then heated at a constant pressure till its enthalpy increases by 70 kJ. Determine the total work done. C_p = 1 kJ/Kg K and C_v = 1 kJ/KgK.

12\. (a) A reversible heat engine operates between two reservoirs at temperatures 700°C and 50° C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 50°C and -25°C. The heat transfer to the engine is 2500 kg and the net work output of the combine's engine refrigerator plant is 400 kJ.

(i) Determine the heat transfer to the refrigerant and the net heat transfer to the reservoir at 50°C;

(ii) Reconsider (i) given that the efficiency of the heat engine and the C.O. P of the refrigerator are each 45 percent of their maximum possible values.

Or

(b) An ideal gas of mass 0.25 kg has a pressure of 3 bar, a temperature of 80°C and a volume of 0.07 m^3 The gas undergoes an irreversible adiabatic process to a final pressure of 3 bar and a final volume of 0.10 m^3, during which the work done on the gas is 25 kJ. Evaluate C_p and C_v of the gas and increase in entropy of the gas.

13\. (a) A steam power plant operates on the Rankine steam is supplied at a pressure of 1.1 MN/m^2 and with a dryness fraction of 0.95. The steam exhaust in to a condenser at a pressure of 12 kN/m^2. Determine the rankine efficiency.

Or

(b) Calculate the internal energy per kg of super heated steam at a pressure of 10 bar and a temperature of 300°C. Also find the change of internal energy if this steam is expanded to 1.4 bar and dryness fraction 0.8.

14. (a) Derive the Maxwell relations and explain their importance in thermodynamics.

Or

(b) Using Clausius-Claperyon's equation, estimate the enthalpy of vapourisation. The following data is given :

At 200°C; $V_g = 0.127\ m^3/k_g$; $vf = 0.001157\ m^3/kg$; $\left(\frac{dp}{dt}\right) = 32$ kPa/K

15. (a) Describe the following processes:

(i) Sensible heating. (6)

(ii) Heating and dehumidification. (7)

Or

(b) 40 m^3 of air at 35°C DBT and 50% R.H. is cooled to 25°C DBT maintaining its specific humidity constant. Determine :

(i) Relative humidity (R.H) of cooled air;

(ii) Heat removed from air.

PART C — (1 × 15 = 15 marks)

16. (a) A gas of mass 1 .5 kg undergoes a quasi-static expansion which follows a relationship p = a + bv, where a and b are constants. The initial and final pressures are 1000 kPa and 200 kPa respectively and the corresponding volumes are 0.20 m^3 and 1.20 m^3, The specific internal energy of the gas is given by the relation

$u = 1.5\ pv - 85$ kJ/kg

Where p is the kPa and v is in m^3/kg. Calculate the net heat transfer and the maximum internal energy of the gas attained during expansion.

Or

(b) One kg-mol of oxygen undergoes a reversible non-flow isothermal compression and the volume decreases from 0.2 m^3/kg to 0.08 m^3/kg and the initial temperature is 60°C, if the gas obeys Van der Waals's equation find:

(i) The work done during the process

(ii) The final pressure.