Reg. No. :

Question Paper Code : X20833

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2020
AND APRIL/MAY 2021
Third Semester
Mechanical Engineering
ME 6301 – ENGINEERING THERMODYNAMICS
(Common to Automation Engineering, Mechanical and Automation Engineering)
(Regulations 2013)
(Also common to PTME 6301 – Engineering Thermodynamics for B.E. Part time
– Second Semester – Mechanical Engineering – Regulations 2014)

Time : Three Hours Maximum : 100 Marks

Use of approved Thermodynamics Tables, Mollier diagram, Psychrometric Chart and Refrigerant property tables permitted in the Examinations
Answer ALL questions.

PART – A **(10×2=20 Marks)**

1. Write down the equation for first law for a steady flow process.

2. Give the energy equation applicable for an adiabatic nozzle and an adiabatic turbine.

3. What is PMM2 ?

4. What do you understand by high grade energy and low grade energy ?

5. Define Degree of saturation.

6. State Gibbs-Dalton's law.

7. What are reduced properties ?

8. Write down the two Tds equations.

9. What is Amagat's law ?

10. What is sensible heating ?

PART – B **(5×13=65 Marks)**

11. a) A mass of air is initially at 260 °C and 700 kPa and occupies 0.028 m^3. The air is expanded at constant pressure to 0.084 m^3. A polytropic process with n = 1.5 is then carried out followed by a constant temperature process which completes a cycle. All the process are reversible.

   1) Sketch the cycle in T-S and P-V planes. **(4)**
   2) Find the heat received and heat rejected in the cycle. **(4)**
   3) Find the efficiency of the cycle. **(5)**

(OR)

b) i) A room for four person has 2 fans, each consuming 0.18 kW power, and three 100 W lamps. Ventilation air at the rate of 80 kg/hr enters with an enthalpy of 84 kJ/kg and leaves with an enthalpy of 59 kJ/kg. If each person puts out heat at the rate of 630 kj/hr. Determine the rate at which heat is removed by a room cooler, so that a steady state is maintained in the room. **(6)**

ii) An insulated rigid tank of 1.5 m^3 of air with a pressure of 6 bar and 100°C discharges air 1 to the atmosphere which is at 1 bar through a discharge pipe till its pressure becomes 1 bar.

   1) Calculate the velocity of air in the discharge pipe. **(3)**
   2) Evaluate the work that can be obtained from the frictionless turbine using the kinetic energy of that air. **(4)**

12. a) i) A heat pump operates on a Carnot heat pump cycle with a COP of 8.7. It keeps a space at 24°C by consuming 2.15 kW of power. Determine the temperature of the reservoir from which the heat is absorbed and the heating load provided by the heat pump. **(7)**

ii) An inventor claims to have developed a refrigeration system that removes heat from the closed region at –12°C and transfers it to the surrounding air at 25°C while maintaining a COP of 6.5. Is this claim reasonable ? Why ? **(6)**

(OR)

b) i) A 30-kg iron block and a 40-kg copper block, both initially at 80°C, are dropped into a large lake at 15°C. Thermal equilibrium is established after a while as a result of heat transfer between the blocks and the lake water. Determine the total entropy change for this process. **(8)**

ii) How much of the 100 kJ of thermal energy at 650 K can be converted to useful work ? Assume the environment to be at 25°C. **(5)**

13. a) A vessel of volume 0.04 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 9 kg. Find the pressure, the mass, the specific volume, the enthalpy and entropy and the internal energy of the mixture.

(OR)

b) A steam power plant operates on a simple ideal Rankine cycle between the pressure limits of 3 MPa and 50 kPa. The temperature of the steam at the turbine inlet is 300°C and the mass flow rate of steam through the cycle is 35 kg/s. Show the cycle on a T-s diagram with respect to saturation lines, and determine.

i) The thermal efficiency of the cycle and

ii) The net power output of the power plant.

14. a) Draw the p-V, T-S, h-S diagrams and theoretical lay out for Rankine cycle and hence deduce the expression for its efficiency.

(OR)

b) i) State the advantages of using super heated steam in vapour power cycles. **(5)**

ii) A vessel with a capacity of 0.05 m^3 contains a mixture of saturated water and saturated steam at a temperature of 245°C. The mass of the liquid present is 10 kg. Find the following:

1) The pressure,
2) The mass,
3) The specific volume
4) The specific enthalpy,
5) The specific entropy, and
6) The specific internal energy. **(8)**

15. a) Atmospheric air at 101.325 kPa and 288.15 K contains 21% oxygen and 79% nitrogen, by volume. Calculate the

i) Mole fractions, mass fractions and partial pressures of oxygen and nitrogen and

ii) Molar mass, gas constant and density of the air.
Take molar mass of oxygen and nitrogen as 32 and 28 kg/kmol.

(OR)

b) Air at 20°C, 40% RH is mixed adiabatically with air at 40°C, 40% RH in the ratio of 1 kg of the former with 2 kg of the latter (on dry basis). Determine the specific humidity and the enthalpy of the mixed stream.

PART – C **(1×15= 15 Marks)**

16. a) A quantity of air undergoes a thermodynamic cycle consisting of three processes. Process 1 – 2 : Constant volume heating from P_1 = 0.1 MPa, T_1 = 15°C, V_1 = 0.02 m^3 to P_2 = 0.42 MPa. Process 2-3 : Constant pressure cooling. Process 3-1 : Isothermal heating to the initial state. Employing the ideal gas model with C_p = 1 kJ/kgK, evaluate the change of entropy for each process. Sketch the cycle on p-v and T-s coordinates.

(OR)

b) Air at 80 kPa, 27°C and 220 m/s enters a diffuser at a rate of 2.5 kg/s and leaves at 42°C. The exit area of the diffuser is 400 cm^2. The air is estimated to lose heat at a rate of 18 kJ/s during this process. Determine :

i) The exit velocity and

ii) The exit pressure of the air.

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