Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 60845

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Third Semester

Mechanical Engineering

ME 2202/ME 33/ME 1201/080190005/10122 ME 303/AT 2203/AT 36/
10122 AU 302 — ENGINEERING THERMODYNAMICS

(Common to Automobile Engineering)

(Regulations 2008/2010)

(Common to PTME 2202/10122 ME 303 Engineering Thermodynamics for B.E. (Part-Time) Third Semester – Mechanical Engineering – Regulations 2009/2010)

Time : Three hours Maximum : 100 marks

(Use of approved thermodynamics tables, Mollier diagram, Psychometric chart and Refrigerant property tables permitted in the Examination)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is microscopic approach in thermodynamics?

2. Define extensive property.

3. Differentiate between a Refrigerator and a heat pump.

4. What are 'available energy' and 'unavailable energy'?

5. Define Exergy.

6. What is meant by dead state?

7. A domestic food freezer maintains a temperature of — 15°C. The ambient air temperature is 30°C. If the heat leaks into the freezer 1.75 kJ/s continuously, what is the least power necessary to pump this heat out continuously?

8. One kg of an ideal gas is heated from 18°C to 93°C. Taking R = 269 Nm/kg-K and $\gamma = 1.2$ for the gas, find the change in internal energy.

9. What is the relative humidity of air if the DPT and DBT are 25°C and 30°C at 1 atmospheric pressure?

10. What is adiabatic evaporative cooling?

PART B — (5 × 16 = 80 marks)

11. (a) A three process cycle operating with nitrogen as the working substance has constant temperature compression at 34°C with initial pressure 100 kPa. Then the gas undergoes a constant volume heating and then polytropic expansion with 1.35 as index of compression. The isothermal compression requires –67 kJ/kg of work. Determine

(i) P, v and T around the cycle

(ii) Heat in and out

(iii) Net work

For nitrogen gas, $C_v = 0.7431$ kJ/kg–K. (16)

Or

(b) (i) Derive the steady flow energy equation, stating the assumptions made. (6)

(ii) Prove that energy is a property of a system. (5)

(iii) Enumerate and explain the limitations of first law of thermodynamics. (5)

12. (a) (i) Two Carnot engines A and B are operated in series. The first one receives heat at 870°K and rejects to a reservoir at T. B receives heat rejected by the first engine and in turn rejects to a sink at 300°K. Find the temperature T for

(1) The work outputs of both engines (6)

(2) Same Efficiencies. (6)

(ii) Mention the Clausius inequality for open, closed and isolated systems. (4)

Or

(b) (i) 3 kg of air at 500 kPa, 90°C expands adiabatically in a closed system until its volume is doubled and its temperature becomes equal to that of the surroundings at 100 kPa and 10°C. Find maximum work, change in availability and the irreversibility. (12)

(ii) Briefly discuss about the concept of entropy. (4)

13. (a) A power generating plant uses steam as a working fluid and operate at a boiler pressure of 50 bar, dry saturated and a condenser pressure of 0.05 bar. Determine the cycle efficiency, work ratio and specific steam consumption for Rankine cycle.

Or

(b) A steam power plant operates on a theoretical reheat cycle. Steam at 25 bar pressure and 400°C is supplied to the high pressure turbine. After its expansion to dry state the steam is reheated at a constant pressure to its original temperature. Subsequent expansion occurs in the low pressure turbine to a condenser pressure of 0.04 bar. Considering feed pump work, make calculation to determine (i) quality of steam at entry to condenser (ii) thermal efficiency (iii) specific steam consumption.

14. (a) (i) One kg of ideal gas is heated from 50°C to 150°C. If R = 280 kJ/kgK and $\gamma = 1.32$ for the gas, determine

(1) C_p and C_v,

(2) Change in internal energy,

(3) Change in enthalpy,

(4) Change in flow energy. (8)

(ii) Two moles of an ideal gas at temperature 'T' and pressure 'p' are contained in a compartment. An adjacent compartment contain one mole of an ideal gas at temperature '$2T$' and pressure 'p'. The gases mix adiabatically but do not react chemically when a partition separating the component is withdrawn and the temperature of the mixture is '$\left(\frac{4}{3}\right)T$'. Show that the entropy increase due to the mixing process is given by $R\left(\ln\frac{27}{4} + \frac{\gamma}{\gamma-1}\ln\frac{32}{27}\right)$

Assume that the gases are different and the ratio of specific heat 'γ' is the same for both gases and remains constant. (8)

Or

(b) (i) Based on Maxwell's relations, prove that for any fluid, $dS - C_v\frac{dT}{t} + \left(\frac{\partial p}{\partial T}\right)_v dV$. (8)

(ii) A mixture of 3 moles of helium, 4 moles of neon amid 5 moles of argon is at 1 bar and 300°K. Calculate

(1) volume,

(2) mole fraction and partial pressure of gases and

(3) change of entropy due to mixing. (8)

15. (a) Atmospheric air at 1.0132 bar has 20°C DBT and 65% RH. Find the humidity ratio, wet bulb temperature, dew point temperature, degree of saturation, enthalpy of the mixture, density of air and density of vapour in the mixture. (16)

Or

(b) (i) Atmospheric air at 38°C and 25% relative humidity passes through an evaporative cooler. If the final temperature of air is 18°C, how much water is added per kg of dry air and what is the final relative humidity? (10)

(ii) Show the process of adiabatic mixing on a sketch of skeleton psychrometric chart and explain the process. (6)

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