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

Question Paper Code : 91631

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2014.

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 – Regulation 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 zeroth law of thermodynamics?

2. Compare heat transfer with work transfer.

3. State Kelvin Planck's statement.

4. What is the entropy principle?

5. What is flow and non-flow process?

6. Write the methods for improving the performance of the Rankine cycle.

7. What are the properties of ideal gas?

8. State the Vander Waal's equation of state.

9. What is adiabatic evaporative cooling?

10. What is the use of sling psychrometer?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Derive an expression for the work transfer, heat transfer and change in internal energy for an isobaric and isochoric process. (8)

(ii) Define enthalpy. How is it related to internal energy? (8)

Or

(b) Air at a temperature of 15°C passes through a heat exchanger at a velocity of 30 m/s where its temperature is raised to 800°C. It then enters a turbine with the same velocity of 30 m/s and expands until the temperature falls to 650°C. On leaving the turbine, the air is taken at a velocity of 60 m/s to a nozzle where its expands until the temperature has fallen to 500°C. If the air flow rate is 2 kg/s, calculate (i) the rate of heat transfer to the air in the heat exchanger, (ii) the power output from the turbine assuming no heat loss, and (iii) the velocity at exit from nozzle, assuming no heat loss. Take the entropy of air as $h = c_p t$, where c_p is the specific heat equal to 1.005 kJ/kg K and t the temperature.

12. (a) (i) State and prove Clausius inequality. (4)

(ii) A reversible heat engine operates between two reservoirs at temperature of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoirs at temperature of 40°C and –20°C. The heat transfer to the heat engine is 2000 kJ and the network output of the combined engine refrigerator plant is 360 kJ. (1) Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40°C. (2) Reconsider (1) given that the efficiency of the heat engine and the COP of the refrigerator are each 40% of their maximum possible values. (12)

Or

(b) (i) Briefly discuss about the concept of entropy. (6)

(ii) Liquid water of mass 10 kg and temperature 20°C is mixed with 2 kg of ice at –5°C till equilibrium is reached at 1 atm pressure. Find the entropy change of the system. Given : C_p of ice = 2.09 kJ/kg K and latent heat of ice = 334 kJ/kg. (10)

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, the entropy and internal energy.

Or

(b) Steam at 20 bar, 360°C is expanded in a steam turbine to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. (i) Assuming ideal process, find per kg of steam the network and the cycle efficiency. (ii) If the turbine and the pump have each 80% efficiency, find the percentage reduction in the network and cycle efficiency.

14. (a) A mixture of ideal gases consists of 3 kg of nitrogen and 5 kg of CO_2 at a pressure of 3 bar and a temperature of 20°C. Find (i) mole fraction of each constituent, (ii) the equivalent molecular weight of the mixture, (iii) the equivalent gas constant of the mixture, (iv) the partial pressures and the partial volumes, (v) the volume and density of the mixture, and (vi) the C_p and C_v of the mixture. Take γ for CO_2 and N_2 to be 1.286 and 1.4 respectively.

Or

(b) (i) Derive any two Maxwell's relation. (8)

(ii) Deduce the expression for Joule-Thomson coefficient and draw the inversion curve. (8)

15. (a) 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). Find the final condition of air.

Or

(b) (i) Explain adiabatic saturation with a schematic diagram. (8)

(ii) A sling psychrometer reads 35°C DBT and 30°C WBT. Find the humidity ratio, relative humidity, dew point temperature, specific volume, and enthalpy of air. (8)

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