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Question Paper Code : 71845

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

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)

(Regulation 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 — ($10 \times 2 = 20$ marks)

1. Define the Zeroth law of thermodynamics. Why is it so called?

2. List any five physical properties of matter which can be used for measurement of temperature.

3. A closed insulated vessel contains 200 kg of water. A paddle wheel immersed in the water is driven at 400 rev/min with an average torque of 500 Nm. If the test run is made for 30 minutes, determine rise in the temperature of water. Take specific heat of water 4.186 kJ/kgK.

4. A heat engine is supplied with 2512 kJ/min of heat at 650°C. heat rejection takes place at 100°C. Specify which of the following heat rejection represents a reversible, irreversible or impossible result

   (a) 867 kJ/min

   (b) 1015 kJ/min.

5. Superheated steam at 30 bar and 300°C enters a turbine and is expanded to 5 bar and quality 0.974 dryness, compute the loss in availability for the adiabatic process if the atmospheric temperature is 270°C.

6. Define second law of thermodynamics.

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. Carnot refrigerator requires 1.25 kW per ton of refrigeration to maintain the temperature of 243 K. Find the COP of Carnot refrigerator.

10. Ice is formed at 0°C from water at 20°C. The temperature of the brine is –10°C. Find the ice formed per kW hour. Assume that refrigeration cycle used is perfect reversed Carnot cycle. Latent heat of ice = 80 kcal/kg.

PART B — (5 × 16 = 80 marks)

11. (a) A thermodynamic system operates under steady flow conditions, the fluid entering at 2 bar and leaving at 10 bar. The entry velocity is 30 m/s and exit velocity is 10 m/s. During the process 25 MJ/hr of heat from an external source is supplied and the increase in enthalpy is 5 kJ/kg. The exit point is 20 m above the entry point. Determine flow work from the system if the fluid flow rate is 45 kg/min.

Or

(b) A vessel of constant volume 0.3 m^3 contains air at 1.5 bar and is connected, via a valve, to a large main carrying air at a temperature of 38°C and high pressure. The valve is opened allowing air to enter the vessel and raising the pressure therein to 7.5 bar. Assuming the vessel and valve to be thermally insulated, find the mass of air entering the vessel.

12. (a) Three Carnot engines A, B and C working between the temperature of 1000 K and 300 K are in a series combination. The work produced by these engines are in the ratios of 5 : 4 : 3. Make calculations of temperature for intermediate reservoirs.

Or

(b) A reversible engine operates between temperature T_1 and $T(T_1 > T)$. The energy rejected by this engine is received by a second reversible engine at the same temperature T. The second engine rejects the heat at temperature $T_2(T_2 < T)$. Prove that $T = (T_1 + T_2)/2$ if the engines produce same work output.

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) A tank of 0.2 m^3 capacity contains O_2 at 15 bar and 400°C. A second tank of 0.5 m^3 contains N_2 at 20 bar and 300°C. The two tanks are connected together and allowed to mix. The heat lost during mixing is 50 kJ. Determine the final pressure, final temperature of the mixture and net entropy change due to mixing.

Or

(b) Five moles of gas mixture contains 45% N_2, 27% He and 28% C_6H_6 by mass. Find (i) the analysis by volume and the number of moles of each constituent (ii) the volume of mixture at 3.5 bar pressure and 20°C.

15. (a) A certain sample of moist air exists at 35°CDBT and 20°C dew point temperature the atmospheric pressure is 760 mm of mercury. Calculate the relative humidity and saturation ratio.

Or

(b) (i) Explain the process of cooling dehumidification of air. (8)

(ii) Draw the psychrometric chart and show any two psychrometric processes on it. (4)

(iii) What is moist air and saturated air. (4)