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B.E./B.Tech. DEGREE EXAMINATIONS, NOV./DEC. 2020

Third Semester

Mechanical Engineering

ME 2202/ME 1201/080190005/10122ME 303/AT 36/ ME 33 – ENGINEERING THERMODYNAMICS

(Common to Automobile Engineering)

(Regulations 2008/2010)

(Also Common to PTME 2202/10122ME303- Engineering Thermodynamics for B.E. (Part-Time) Third Semester-Mechanical Engineering – Regulations 2009/2010)

Time : Three Hours Maximum : 100 Marks

(Use of approved thermodynamic tables, Mollier diagram, Psychometric chart and Refrigerant property tables are permitted in the examination)

Answer ALL questions.

PART – A **(10×2=20 Marks)**

1. Distinguish between the terms 'state' and 'process' of thermodynamics.
2. State the First law of thermodynamics for a non-flow process and for a cycle.
3. List the limitations of First Law of Thermodynamics.
4. In an isothermal process 1000 kJ of work is done by the system at a temperature of 200°C. What is the entropy change of this process ?
5. What is normal boiling point ?
6. When is reheat recommended in a steam power plant ?
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 γ = 1.2 for the gas, find the change in internal energy.
9. When is humidification of air necessary ?
10. How does the wet bulb temperature differ from the dry bulb temperature ?

PART – B **(5×16= 80 Marks)**

11\. a) i) Define heat and show that heat is a path function and not a property. **(4)**

ii) A fluid system, contained in a piston and cylinder machine, passes through a complete cycle of four processes. The sum of all heat transferred during a cycle is –340 kJ. The system completes 200 cycles per min.

Process	Q(kJ/min)	W(kJ/min)	ΔE(kJ/min)
1 – 2	0	4340	–
2 – 3	42000	0	–
3 – 4	–4200	–	–73200
4 – 1	–	–	–

Complete the above table showing the method for each item and compute the net rate of work output in kW. **(12)**

(OR)

b) i) Air is compressed from 100 kPa and 22° C to a pressure of 1 MPa while being cooled at the rate of 16 kJ/kg by circulating water through the compressor casing. The volume flow rate of air at inlet condition is 150 m^3/min and power input to compressor is 500 kW. Neglecting the gravitational potential energy, determine the mass flow rate and the temperature of air at exit. **(8)**

ii) Air flows steadily at the rate of 0.4 kg/s through an air compressor, entering at 6 m/s with a pressure of 1 bar and a specific volume of 0.85 m^3/kg and leaving at 4.5 m/s with a pressure of 6.9 bar and a specific volume of 0.16 m^3/kg. The internal energy of air leaving is 88 kJ/kg greater than that of the air entering. Cooling water in a jacket surrounding the cylinder absorbs heat from the air at the rate of 59 W. Calculate the power required to drive the compressor and the inlet and outlet cross-sectional area. **(8)**

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) i) Explain the phase transformation that takes place when ice (solid) is heated continuously till superheated steam is obtained. Name the different states involved. Sketch the transformation on a 'temperature' vs 'heat added' diagram. (8)

ii) 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, mass, the specific volume, the enthalpy, the entropy and the internal energy. **(8)**

(OR)

b) i) Define specific steam consumption, specific heat rate and work ratio. **(6)**

ii) Steam enters the turbine at 3 MPa and 400°C and is condensed at 10 kPa. Some quantity of steam leaves the turbine at 0.6 MPa and enters feed water heater. Compute the fraction of the steam extracted per kg of steam and cycle thermal efficiency. **(10)**

14. a) A mass of 0.25 kg of an ideal gas has a pressure of 300 kpa, 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 300 kPa and final volume of 0.10 m^3, during which workdone on the gas is 25 kJ. Evaluate c_p and c_v of the gas the increase in entropy of the gas. **(16)**

(OR)

b) The gas neon has a molecular weight of 20.183 and its critical temperature, pressure and volume are 44.5 k, 2.73 MPa and 0.0416 m^3/kg mol. Reading from a compressibility chart for a reduced pressure of 2 and a reduced pressure of 1.3, the compressibility factor z is 0.7. What are the corresponding specific volume, pressure, temperature and reduced volume ? **(16)**

15. a) i) Derive the sensible heat factor for cooling and dehumidification process. Also explain the process. **(6)**

ii) One kg of air at 40°C dry bulb temperature and 50% relative humidity is mixed with 2kg of air at 20°C dry bulb temperature and 20°C dew point temperature. Calculate the temperature and specific humidity of the mixture. **(10)**

(OR)

b) i) Prove that specific humidity of air is $\omega = 0.622 \frac{P_v}{P_b - P_v}$. **(6)**

ii) With the aid of model psychometric chart explain the following processes : **(10)**

1) Adiabatic mixing

2) Evaporative cooling.