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

Question Paper Code: 33703

B.E. / B.Tech. DEGREE EXAMINATION, APRIL 2019

Third Semester

Mechanical Engineering

01UME303 - ENGINEERING THERMODYAMICS

(Use of steam tables, charts may be permitted)

(Regulation 2013)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 2 = 20 Marks)

1. Define thermodynamic system.
2. Define Perpetual Motion Machine of first kind (PMM - 1).
3. State the Clausius statement of the second law of thermodynamics.
4. Write the Clausius inequality equation and provide the criterion of the reversibility of a cycle.
5. What is triple point?
6. What is degree of superheat?
7. What is an equation of state?
8. What is Joule-Thomson coefficient? Why it is zero for an ideal gas?
9. What is specific humidity? When does it become maximum?
10. What is adiabatic mixing and write the equation for that?

PART - B (5 x 16 = 80 Marks)

11. (a) A piston and cylinder machine contains a fluid system which passes through a complete cycle of four processes. During a cycle, the sum of all heat transfer is –170 kJ. The system completes 100 cycles/min. Complete the following table showing the method for each item, and computes the net rate of work out put in kW.

Process	Q (kJ/min)	Q (kJ/min)	Δ E (kJ/min)
a – b	0	2,170	--
b – c	21,000	0	--
c – d	- 2,100	--	- 36,600
d – a	--	--	--

(16)

Or

(b) Derive the general energy equation for a steady flow system and apply the equation to a nozzle and derive an equation for velocity at exit. (16)

12. (a) A reversible heat engine in a satellite operates between a hot reservoir at T_1 and a radiating panel at T_2. Radiation from the panel is proportional to its area and to T_2^4. For a given work output and value of T_1, show that the area of the panel will be minimum when $\frac{T_2}{T_1} = 0.75$. Determine the minimum area of the panel for an output of 1 *kW* if the constant of proportionality is 5.67 x 10^{-8} W/m^2K^4 and T_1 is 1000 *K*. (16)

Or

(b) A reversible engine operates between a source at 972^oC and two sinks, one at 127^oC and another at 27^oC. The energy rejected is same at both the sinks. What is the ratio of heat supplied to the heat rejected? Also calculate the efficiency. (16)

13. (a) A steam boiler initially contains 9 m^3 of water and 1 m^3 of steam at 2 *MPa* pressure. Heat is added and steam is utilized at constant pressure, till the boiler finally contains 1 m^3 of water and 9 m^3 of steam. Calculate (i) the mass of steam utilized and (ii) the required steam supply. (16)

Or

(b) A steam turbine with an internal efficiency of 90% receives steam at 7 *MPa* and 550^oC and exhausts at 20 *kPa*. Determine the turbine work, exhaust enthalpy and exit quality of the steam. (16)

14. (a) Molar analysis of air indicates that it is composed primarily of nitrogen (78%) and oxygen (22%). Determine (a) the mole fractions (b) the gravimetric analysis (c) its molecular weight (d) its gas constant. (16)

Or

(b) (i) Prove that $\left(\frac{\partial P}{\partial V}\right)_T \left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial T}{\partial P}\right)_V = -1$ (8)

(ii) Derive any two Maxwell's relations. (8)

15. (a) (i) Air at 20^oC, 40% R.H is mixed with air at 40^oC, 40% R.H in the ratio of (former) 1:2 (later) on dry basis. Determine the final condition of air. (10)

(ii) Briefly discuss about evaporative cooling process. (6)

Or

(b) (i) In an adiabatic mixing of two streams, derive the relationship among the ratio of mass of streams, ratio of enthalpy change and ratio of specific humidity change. (8)

(ii) Saturated air at 20^oC at a rate of 1.167 m^3/s is mixed adiabatically with the outside air at 35^oC and 50% relative humidity at a rate of 0.5 m^3/s. Assuming adiabatic mixing condition at 1 atm, determine specific humidity, relative humidity, dry bulb temperature and volume flow rate of the mixture. (8)

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