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

Question Paper Code: 31073

B.E. / B.Tech. DEGREE EXAMINATION, OCTOBER 2014.

Third Semester

Mechanical Engineering

01UME 303 – ENGINEERING THERMODYNAMICS

(Regulation 2013)

Duration: Three hours Maximum: 100 Marks

(Standard Steam Tables and Psychrometric Charts are permitted)

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. State Dalton's law of partial pressure.
8. Write Clausius Clapeyron equation.
9. Define relative humidity.
10. What is dew point temperature?

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) 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 areas. (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) (i) Show that the maximum work obtainable from two finite bodies at temperatures T_1 and T_2 is $C_p\left(\sqrt{T_1} - \sqrt{T_2}\right)^2$ (10)

(ii) Prove that two reversible adiabatic paths cannot intersect each other on PV plot. (6)

13. (a) A vessel of volume 0.04 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250^oC. The mass of the liquid present is 9 *kg*. Find the pressure, the mass, the specific volume, the enthalpy, the entropy and the internal energy of the mixture. (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) (i) Derive the two Tds relations. (8)

(ii) Prove that $C_P - C_V = -T\left(\frac{\partial V}{\partial T}\right)_P^2 \left(\frac{\partial P}{\partial V}\right)_T$ from Tds equations. (8)

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) Explain the following

(i) Heating and humidification (8)

(ii) Adiabatic mixing of two streams. (8)

Or

(b) An air conditioning system is designed under the following conditions.

Out door conditions	: 30^oC DBT, 75% RH
Indoor conditions	: 22^oC DBT, 70% RH
Amount of free air supplied	: 3.33 m^3/s
Coil dew point temperature	: 14^oC

The required condition is achieved first by cooling and dehumidification and then by heating. Estimate

(i) Capacity of the cooling coil in TR

(ii) Capacity of the heating coil in kW and

(iii) The amount of water vapour removed in kg/s. (16)