Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (New) EXAMINATION – WINTER 2015

Subject Code:2143406 **Date:19/12/2015**

Subject Name: Thermodynamics & Thermal Engineering

Time: 2:30pm to 5:00pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of steam table is permitted.**

Q.1	**(a)**	Define the terms: (i) Thermodynamics (ii) System (iii) Extensive properties (iv) Quasi-static process (v) Cycle (vi) Mechanical equilibrium (vii) Pure substance	**07**
	(b)	Prove that energy is a point function of a system undergoing change of state.	**07**
Q.2	**(a)**	State the first law of thermodynamics and prove that for a non-flow process, it leads to the energy equation $Q= \Delta U + W$.	**07**
	(b)	Give the comparison between Rankine cycle and Carnot cycle using various diagrams.	**07**
		OR	
	(b)	With the help of p-V diagram derive the air standard efficiency equation for constant volume cycle.	**07**
Q.3	**(a)**	Define available and unavailable energy and explain available energy referred to a cycle.	**07**
	(b)	Air at 1 bar, 22˚C, initially occupying a cylinder volume of 0.015 m^3 is compressed reversibly and adiabatically by a piston to a pressure of 7 bar. Calculate: (i) the final temperature (ii) the final volume (iii) the work done.	**07**
		OR	
Q.3	**(a)**	Derive the Joule-Thomson co-efficient.	**07**
	(b)	Using the first Maxwell equation, derive the remaining three equations.	**07**
Q.4	**(a)**	Derive Van der Waals' equation.	**07**
	(b)	In a Rankine cycle, the steam at inlet to turbine is saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. Determine: (i) the pump work (ii) the turbine work (iii) the Rankine efficiency (iv) the dryness fraction at the end of expansion. Assume mass flow rate of 9.5 Kg/s.	**07**
		OR	
Q.4	**(a)**	Explain Dalton's law and Gibbs-Dalton law in detail.	**07**
	(b)	A spherical shaped balloon of 12m diameter contains H_2 at 30˚C and 1.21bar. Find the mass of H_2 in the balloon using real gas equation. Take Z=1 from compressibility chart.	**07**
Q.5	**(a)**	Explain the head conduction through plane and composite wall.	**07**
	(b)	A furnace wall 350 mm thick, is made up of an inner layer of fire brick (k=0.85 W/m˚C) covered with a layer of insulation (k=0.15 W/m˚C). The furnace operates at a temperature of 1325 ˚C and the ambient temperature of 25˚C. Determine: (i) the thickness of furnace brick and insulation which gives minimum heat loss. (ii) the heat loss presuming that the insulating material has a maximum temperature of 1200˚C.	**07**

OR

Q.5	**(a)**	Derive the equation of critical thickness of insulation for cylinder.	**07**
	(b)	A body at 1000°C in black surrounding at 500°C has an emissivity of 0.45 at 1000°C and an emissivity of 0.72 at 500°C. Calculate the rate of heat loss by radiation per m^2. (i) When the body is assumed to be gray with $\varepsilon = 0.45$ (ii) when the body is not gray. Assume that the absorptivity is independent of the surface temperature.	**07**

****