Q. Code: 529611

Reg. No.

B.E. / B.TECH. DEGREE EXAMINATIONS, DEC 2019

Fourth Semester

CH16402 – CHEMICAL ENGINEERING THERMODYNAMICS I

(Chemical Engineering)

(Regulation 2016)

Time: Three Hours **Maximum : 100 Marks**

Answer **ALL** questions

PART A - (10 X 2 = 20 Marks)

		CO	RBT
1.	Write the limitations of thermodynamics.	**1**	**R**
2.	Explain thermodynamic equilibrium.	**1**	**U**
3.	State compressibility factor.	**2**	**R**
4.	Differentiate between flow and non-flow processes. Give examples.	**2**	**U**
5.	What are the statements of Second law of thermodynamics?	**3**	**R**
6.	Distinguish Available and Unavailable energies.	**2**	**U**
7.	What are thermodynamic diagrams? Give its application.	**4**	**R**
8.	Define Joule-Thomson coefficient.	**4**	**R**
9.	What are thermodynamic diagrams? Give its application.	**4**	**R**
10.	Why inter-stage cooling is necessary in a multi-stage compression?	**3**	**R**

PART B - (5 X16 = 80 Marks)

11.	(a)	Five kilograms of CO_2 gas is contained in a piston cylinder assembly at a pressure of 7.5 bar and a temperature of 300 K. The piston has a mass of 6000 Kg and a surface area of 1 m^2. The friction of the piston on the walls is insignificant. The atmospheric pressure is 1.0135 bar. The latch holding the piston in position is suddenly removed and the gas is allowed to expand. The expansion is arrested when the volume is double the original volume. Determine the work done in the surroundings.	**(16)**	**1**	**AP**

(OR)

(b) (i) A spherical balloon of diameter 0.5 m contains gas at 1 bar and 300 K. The gas is heated and the balloon is allowed to expand. The pressure inside the balloon is directly proportional to the diameter. What would be the work done by the gas when the pressure inside reaches 5 bar? **(8)** 1 **AP**

(ii) The turbine in a hydroelectric power plant is fed by water falling from a 50 m height. Assuming 91% efficiency of for conversion of potential to kinetic energy and 8% loss of the resulting power in transmission, what is the mass flow rate of water required to power a 200 W light bulb. **(8)** 1 **AP**

12. (a) (i) One kilo mol CO2 occupies a volume of 0.381 m^3 at 313 K. Compare the pressures given by **(8)** 2 **AN**

(a) Ideal gas equation

(b) van der Waals equation

Take the van der Waals constants to be $a = 0.365$ Nm^4/mol^2 and $b = 4.28* 10^{-5}$ m^3/mol.

(ii) Explain the PVT behavior of fluids with a neat sketch. **(8)** 2 **U**

(OR)

(b) Reported values of the virial coefficients of isopropanol vapor at 200^0C are : **(16)** 2 **AN**

$B = -388cm^3\ mol^{-1}$ $C = -26,000\ cm^6\ mol^{-2}$

Calculate V and Z for isopropanol vapor at 200^0C and 10 bar by:

- The ideal gas equation
- Truncated form of virial equation

13. (a) Derive the first law of thermodynamics for a steady-state steady-flow process. **(16)** 3 **U**

(OR)

(b) (i) A central power plant, rated at 900MW, generates stem at 600K and discards heat to a river at 300K. If the thermal efficiency of the plant is 80% of the maximum possible value, how much heat is discarded to the river at rated power? **(8)** 3 **AP**

		(ii)	A lump of steel weighing 30Kg at a temperature of 427^{o}C is dropped in 150Kg of oil at 27^{o}C. The specific heats of the steel and oil are 0.5 and 2.5KJ/Kg K respectively. Estimate the entropy change of the steel, the oil and the system consisting of oil and the lump of steel.	**(8)**	**3**	**AP**
14.	(a)	(i)	State Joule-Thomson effect. Derive an expression for Joule Thomson coefficient in terms of Vander Waals constants ‘a’ and ‘b’.	**(12)**	**4**	**U**
		(ii)	Define Joule Thomson coefficient and prove it is equal to zero for ideal gases.	**(4)**	**4**	**U**
			(OR)			
	(b)	(i)	Derive a relationship between the specific heat at constant pressure and constant volume in terms of coefficient of volume expansion and compressibility.	**(12)**	**4**	**AN**
		(ii)	Enumerate Mollier chart and its significance with a neat sketch.	**(4)**	**4**	**U**
15.	(a)		Write a brief notes on the following; (i) Steam jet ejectors (ii) Adiabatic compression (iii) Isothermalcompression (iv) Multi-stage compression	**(16)**	**4**	**U**
			(OR)			
	(b)		The compression ratio in an air-standard Otto cycle is 8. The temperature and pressure at the beginning of the compression stroke are 290 K and 100 kPa. Heat transferred per cycle is 450 kJ/kg of air. The specific heat of air are C_P = 1.005 kJ/kg K and C_V = 0.718 kJ/kg K. Determine the following: (a) The pressure and temperature of air at the end of each process (b) The thermal efficiency (c) The work done by kg of air (d) The mean effective pressure.	**(16)**	**4**	**AP**