

Ref. No. : Ex/FTBE/BS/B/T/216/2024(S)

B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING SECOND YEAR FIRST SEMESTER SUPPLEMENTARY EXAM– 2024

Subject : CHEMICAL ENGINEERING THERMODYNAMICS

Time: 3hr

Full Marks: 100

Part I (Total Marks 50)

Instructions : Use Separate Answer scripts for each part

Answer any five questions from the following: 5x10=50

1. a) Derive Clausius –Clapeyron Equation. 4
b) What are the assumptions and limitations of Raoult’s Law for Vapour/Liquid Equilibrium? (3+3)=6
2. a) Show the P-V diagram for the following processes:
i. isobaric process
ii. Isochoric process 1.5+1.5=3
b) Write the difference between the following;
Intensive property and Extensive property, State function and Path function. 2+2=4
- c) Prove that slope of adiabatic curve is steeper than isothermal curve. 3
3. Calculate the internal energy and enthalpy changes that occur when air is changed from an initial state of 277K and 10 bar, where its molar volume is $2.28 \text{ m}^3\text{Kmol}^{-1}$ to a final state of 333K and 1atm. Assume for air that PV/T is constant and $c_v=21$ and $c_p=29.3 \text{ KJ/Kmol-K}$.
(a) Cooled at constant volume to the final pressure.
(b) Heated at constant pressure to the final temperature. 10
4. a) Prove that for an adiabatic process $PV^\gamma = \text{Constant}$
b) Define fugacity and activity. 6+4=10
5. Find out
a) Gibb’s Duhem relations
b) Clapeyron equation 6+4=10
6. Deduce the First and Second TdS equation. 5+5=10

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FM-100

Part - II (50 Marks)

(Answer question no 1 or 2 and all from the following)

1. Discuss the working principal of two stroke engine. What are the benefits of relating COP with temperature?
6+4=10
2. A heat pump uses the same equipment as a refrigeration system but works for a different purpose –Justify. What are the different factors contribute the refrigeration load in cold storage?
6+4=10
3. An Otto cycle takes in air at 1 bar and 15°C. The compression ratio is 8 to 1 and 2000 kJ/Kg of energy is released to air in each cycle. To what value must the compression ratio be raised to increase the net work per cycle by 20 percent. Discuss Diesel Cycle with net diagram. 10+10=20
4. A Food Storage locker requires a refrigeration system of 60 KW capacities at an evaporator temperature of -10° C and a condenser temperature of 35°C. the refrigerant used is ammonia which is sub cooled by 5° C before entering the expansion valve and the vapor is dry saturated before leaving the evaporator. The two cylinder compressor with stroke equal to 1.3 times the bore operates at 1000rev/min.

Determine a) the coefficient of performance.

- b) The mass of refrigerant to be circulated per min.
- c) The power required
- d) The heat removed through condenser
- e) Cylinder dimensions

The volumetric efficiency of the compressor is 80%. You may use the extract of ammonia properties from the below

Saturation temp. °C	Pressure bar	Enthalpy kJ/kg		Entropy kJ/kg K		Specific Volume m³/kg		Specific Heat kJ/kg K	
		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor
-10	2.91	154	1450	0.83	5.75	-	0.42	-	2.49
35	13.5	366	1489	1.56	5.21	1.7	0.096	4.56	2.90