Ref. No.: Ex/FTBE/BS/B/T/216/2023

B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING THIRD YEAR FIRST SEMESTER EXAM 2023

Subject-CHEMICAL ENGINEERING THERMODYNAMICSTime- 3 hr FM-100

Part - I (50)

Use separate answer script for each part

(Answer question no 1 and any two from the rest)

1. Discuss the working principal of two stroke engine. What are the benefits of relating COP with temperature? 6+4=10
2. What is vapor compression refrigeration cycle, Discuss with net sketch? Derived an equation for COP of Bel- Coleman Cycle. 10+10+20
3. An air refrigeration open system operating between 0.5 MPa and 50 kPa is required to produce a cooling effect of 2000 kJ/min. the temperature of air leaving the cold chamber is -5^0 C and at leaving the cooler is 30^0C. Neglecting losses and clearance in the composure and expander, determine: a) mass of air circulated per hour, b) compressor work, expander work and the cycle work, c) coefficient of performance and the power required to run the machine.What are the different factors effects the choice of refrigerant?

   12+8=20
4. An air standard Otto cycle is designed to operate with the following data
   Maximum cycle pressure and temperature: 5MPa and 2250K
   Minimum cycle pressure and temperature: 0.2MPa and 300K
   Determine the net work out put per unit mass of working fluid and the thermal efficiency.
   Discuss otto Cycle with net diagram. 12+8=20

[Turn over

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B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING SECOND YEAR FIRST SEMESTER – 2023

Subject : CHEMICAL ENGINEERING THERMODYNAMICS

Time: 3hr **Full Marks:** 100

Part II (Total Marks 50)

Instructions : Use Separate Answer scripts for each part

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

1. i. Differentiate between the following: 2+2=4

a) Closed system and isolated system

b) A process and cycle

ii. Deduce the expression of work done for the following processes

a) Isobaric process

b) Isochoric process

c) Isothermal process

2. a) Prove that for an adiabatic process PV^{γ}=Constant

b) Compare the P-V diagram of an isothermal and adiabatic process. 5+5=10

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 m^3Kmol^{-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 KJ/Kmol-K.

(a) Cooled at constant volume to final pressure.

(b) Heated at constant pressure to final temperature. 10

4. Define

a) chemical potential

b) fugacity

c) activity and activity coefficient 3+3+(2+2)=10

5. Find out

a) Gibb's Duhem relations

b) Clapeyron equation 6+4=10

6. a) What are the assumptions and limitations of Raoult's law.

b) Imagine a subcooled mixture of 40 mol% acetonitrile and 60 mol% nitromethane existing in a piston cylinder arrangement at 348.15 K and system pressure of 65kPa. Provided: P_1^{sat}= 80 kPa and P_2^{sat}= 40 kPa. Calculate the bubble point and dew point composition. 4+6=10

7. A binary system of Acetonitrile (1) / Nitromethane (2) conforms closely to Raoult's law. Vapor pressure for the pure species are given by the following Antoine equations;

$$\ln P_1^{sat}/\text{ kPa} = 14.2724 - 2945.47/(T-49.15)$$

$$\ln P_2^{sat}/\text{ kPa} = 14.2043 - 2972.64/(T-64.15)$$

Using the above equations fill up the following table and prepare a graph of P vs x_1 and P vs y_1 at temperature 348 K

x_1	0.00	0.25	0.50	0.75	1.00
P	?	?	?	?	?
y_1	?	?	?	?	?

10