Ref. No. : Ex/FTBE/T/311/2019

B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING THIRD YEAR FIRST SEMESTER EXAM 2019

Subject-CHEMICAL ENGINEERING THERMODYNAMICS **Time- 3 hr** **FM-100**

Part - I (50)

Use separate answer script for each part

(Answer question no 1 or 2 and any two from the rest)

1. 6 m^3 of gas are allowed to expand at a constant temperature from an initial absolute pressure of 350000 pa to a final absolute pressure of 190000 pa. Determine the final volume. Discuss the function of different components of refrigeration system. 4+6=10
2. Discuss the working principal of two stroke engine. What are the different factors contribute the refrigeration load in cold storage? 6+4=10
3. What is vapor compression refrigeration cycle, Discuss with net sketch? Derived an equation for COP of Bel- Coleman Cycle. 10+10+20
4. An air refrigeration open system operating between 1 MPa and 100kPa 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. How can you measure the amount of water to be removed from steam supply line after a certain distances? 12+8=20
5. An air standard Otto cycle is designed to operate with the following data
   Maximum cycle pressure and temperature: 5 MPa and 2250K
   Maximum cycle pressure and temperature: 0.1 MPa and 300K
   Determine the net work out put per unit mass of working fluid and the thermal efficiency.
   Discuss Diesel Cycle with net diagram. 12+8=20

[Turn over

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Subject: CHEMICAL ENGINEERING THERMODYNAMICS Time: Three Hours Full Marks: 100

Use Separate Answer Scripts for Part I and Part II

Part II (Marks-50)

Group A

Answer any **two** from Group A 10+10=20

1. Define:
a) Fugacity b) Activity c) Chemical Potential d) Phase rule 2.5x4=10

2. a) Derive the First and Second TdS equation.
b) Prove that the Joule-Thomson Coefficient $\mu = -1/Cp\ [\ V - T(\delta V/\delta T)_P\ ]$ (3+3)+4=10

3. a) Derive Clasius-Clapeyron Equation. 5
b) Derive any **two** Maxwell's equation. 2.5+2.5=5

Group B

Answer any **two** from Group B 15+15=30

4. a) Prove that: $dS=Cp.(dT/T)-R.(dP/P)$ .....equation (I)
For an ideal gas with constant heat capacities undergoing a reversible adiabatic (Isentropic) process.
$(T_2/T_1)= (P_2/P_1)^{(\gamma-1)/\gamma}$
Show that the same equation results from application of equation (I) with $\Delta S=0$ 5+5=10
b) Methane gas at 55K and 5 bar undergoes a reversible adiabatic expansion to 1 bar. Assuming methane to be an ideal gas determine the final temperature (Cp value given as: 35.8 J/ mol K). 5

5. Air at 1 bar and 298.15K is compressed to 5 bar and 98.5K by two different mechanically reversible processes
a) Cooling at constant pressure followed by heating at constant volume
b) Heating at constant volume followed by cooling at constant pressure.
Calculate the heat and work requirements, ΔU and ΔH of the air for each path
Cv= 20.78, Cp= 29.10 J /mol-K, assume for air PV/T is a constant. At 298.15K and 1 bar the molar volume of air is 0.02479 m^3/mol. 7.5+7.5=15

6. 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;

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

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

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	0.20	0.40	0.60	0.80	1.00
P	?	?	?	?	?	?
y_1	?	?	?	?	?	?

15