BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: BTECH — **SEMESTER : IV**
BRANCH: BIOTECHNOLOGY — **SESSION : SP/2024**

SUBJECT: BE210 THERMODYNAMICS OF CHEMICAL & BIOLOGICAL SYSTEMS
TIME: 3 Hours — **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	What is thermodynamic quasi-Equilibrium? Calculate expression for work done by system simple compressible gas in adiabatic process. Also draw a P-V diagram for it and compare it with isothermal process.	[5]	3,2	2
Q.1(b)	Steam at 0.4 MPa, 300ºC, enters an adiabatic nozzle with a low velocity and leaves at 0.2 MPa with a quality of 90%. Find the exit velocity, in m/s. Given, At 0.2 MPa h_f = 504.7 kJ/kg and h_{fg} = 2201.6 kJ/kg.	[5]	1,4	5

$$\left.\begin{matrix}\text{Superheated}\\ T_1 = 300^oC\\ P_1 = 0.4\,MPa\end{matrix}\right\} h_1 = 3067.1\frac{kJ}{kg} \qquad \left.\begin{matrix}\text{Saturated Mix.}\\ P_2 = 0.2\,MPa\\ x_2 = 0.90\end{matrix}\right\} h_2$$

Q.2(a)	What are corollaries of second law of thermodynamics? Explain briefly on Clausius Inequality.	[5]	3	4
Q.2(b)	Refrigerant-134a at 700kPa and 100 degC enters an adiabatic nozzle steadily with a velocity of 20 m/s and leaves at 300 kPa and 30 degC. Determine (a) the exit velocity and (b) ratio of the inlet to exit area. Data Given,	[5]	4	5

$$\left.\begin{matrix}P_1 = 700kPa\\ T_1 = 100C\end{matrix}\right\} \upsilon_1 = 0.04064 m^3/kg; h_1 = 338.19 kJ/kg$$

$$\left.\begin{matrix}P_2 = 300kPa\\ T_2 = 30C\end{matrix}\right\} \upsilon_2 = 0.07767 m^3/kg; h_2 = 274.70 kJ/kg$$

Q.3(a)	Compare heat engine and refrigeration cycle. Calculate the efficiency of ideal Rankine cycle with energy analysis. Graphically shows the different ways to increase the efficiency of Rankine cycle.	[5]	4	4
Q.3(b)	Calculate the efficiency of Otto cycle. Compare it with air standard diesel cycle (only efficiency).	[5]	2	4
Q.4(a)	State and explain Gibb's-Duhem equation. The experimental value of the partial molar chemical potential of $CuSO_4$(aq) at 298K is given by the expression chemical potential μ_{CuSO4} / ($cm^3\ mol^{-1}$) = 32 + $15x^{1/2}$ where x is the numerical of the molality of $CuSO_4$. Use the Gibb's Duhem equation to derive an equation for molar chemical potential of water in the solution. Molar chemical potential of pure water is 18 KJ^{-1}	[5]	2,4	4
Q.4(b)	What are colligative properties of any solution? A container is divided into two equal compartments. One contains 3.0 mol H2 at 25 degree centigrade. The other contains 2.0 mol of nitrogen at the same temperature calculate Gibbs energy of mixing when partition is removed. Show that change in enthalpy for mixing is zero.	[5]	3	5

Q.5(a) The vapor pressure of each component in a mixture of acetone (A) and chloroform (C) were at 30 degree centigrade with the following results [5] 3,2 5

Xc	0	0.20	0.40	0.60	0.80	1.0
Pc/Torr	0	30	80	121	272	298
Pa/Torr	350	300	180	105	35	0

Confirm that the mixture conforms to Raoult's law for the component in large excess and to Henry's law for the minor component. Find the Henry's law constants. Calculate the activity and activity coefficient of chloroform in acetone at 30 degree centigrade, treating first as solvent and then second as solute.

Q.5(b) Thermodynamically analyze the energy generation for full oxidation (Glycolysis, TCA cycle, electron transport chain and oxidative phosphorylation) of one mole of glucose molecule. [5] 2,1 4

::::::25/04/2024::::::M