U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

August 2024 Semester End Main Examinations

Programme: B.E. **Semester: IV**
Branch: Biotechnology **Duration: 3 hrs.**
Course Code: 23BT4ESPET / 22BT4ESPET **Max Marks: 100**
Course: Process Engineering Thermodynamics

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

			CO	*PO*	Marks
		UNIT - I			
1	a)	Illustrate the concepts of intensive and extensive properties in thermodynamics. Provide examples for each. Additionally, classify the following properties as either intensive or extensive: pressure, internal energy, temperature, and volume.	*CO* 1	*PO2*	**10**
	b)	State the first law of thermodynamics. Illustrate how it applies to a closed system undergoing a cyclic process. Compute the work done by a gas if it absorbs 1000 J of heat and its internal energy decreases by 200 J.	*CO1*	*PO2*	**10**
		OR			
2	a)	Explain the concept of entropy and its significance in the second law of thermodynamics. Calculate the change in entropy when 500 J of heat is added reversibly to a system at a constant temperature of 300 K.	*CO1*	*PO1*	**10**
	b)	Illustrate the Carnot cycle with the PV diagram emphasize on the importance of Carnot principle in second law of thermodynamics.	*CO1*	*PO2*	**06**
	c)	Calculate the efficiency of a Carnot engine operating between the hot reservoir act 500 K and a cold reservoir at 300 K.	*CO1*	*PO2*	**04**
		UNIT - II			
3	a)	How do the processes involving the ideal gas law differ for constant volume, constant pressure, constant temperature and adiabatic processes?	*CO2*	*PO2*	**06**
	b)	A 1.5 mol sample of an ideal gas undergoes a polytropic process where $PV^{1.3}$=constant. Initially, the gas is at a pressure of 5 atm and a volume of 2.5 L. The final volume of the gas is 4 L. Evaluate the final pressure and the work done by the gas during this process.	*CO2*	*PO2*	**04**
	c)	Calculate the volume occupied by one mole of oxygen gas at 300 K and 100 bar using i. the ideal gas law and ii. the vanderwaals equation taking a=0.1378 N m^4/mol^2 and b=3.18×10^{-5} m^3/mol.	*CO* 2	*PO2*	**10**

			UNIT – III			
	4	a)	Using fundamental property relations, derive Maxwell's equations.	***CO2***	***PO2***	**10**
		b)	A 30% by mole methanol-water solution is to be prepared. How many cubic metres of pure methanol (molar volume, 40.727 x 10^{-6} m^3/mol) and pure water (molar volume, 18.068 x 10^{-6} m^3/mol) are to be mixed to prepare 2 m^3 of the desired solution? The partial molar volumes of methanol and water in a 30 percent solution are 38.632 x 10^{-6} m^3/mol and 17.765 x 10^{-6} m^3/mol, respectively.	***CO2***	***PO2***	**10**
			OR			
	5	a)	Calculate the fugacity of nitrogen at 800 bar from the following data at 273 K. P bar: 50, 100, 200, 400, 800, 1000 PV/RT: 0.9846, 0.9846, 1.0365, 1.2557, 1.7959, 2.0641	***CO2***	***PO2***	**10**
		b)	Derive Gibb's Duhem equation using partial molar properties. Write its applications.	***CO2***	***PO2***	**10**
			UNIT - IV			
	6	a)	Derive the equations representing criteria for phase equilibrium.	***CO*** 3	***PO2***	**08**
		b)	A binary solution of components A and B exhibits non-ideal behavior. At a given temperature, the vapor pressures of the pure components are P_A^0=0.8 atm and P_B^0=0.5 atm The mole fraction of component A in the liquid phase is x_A=0.4 and the total pressure of the system is 0.65 atm. Given the total pressure and the vapor pressures of the pure components, calculate the activity coefficients (γ_A and γ_B) for components A and B.	***CO*** 3	***PO2***	**12**
			UNIT - V			
	7	a)	Explain the thermodynamics of coupled reaction and denaturation of proteins.	***CO4***	***PO2***	**07**
		b)	The standard heat of formation and standard free energy of formation of ammonia at 298 K are -46,000 J/mol and 16,500 J/mol respectively. Compute the equilibrium constant for the reaction. $N_2+3H_2 \rightarrow 2NH_3$ at 500 K assuming that heat of reaction is constant.	***CO3***	***PO2***	**07**
		c)	Illustrate the criteria of reaction equilibrium with the help of G Vs ε plot.	***CO3***	***PO2***	**06**

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