U.S.N.										

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

Autonomous Institute Affiliated to VTU

August 2024 Supplementary Examinations

Programme: B.E. **Semester: IV**
Branch: Biotechnology **Duration: 3 hrs.**
Course Code: 19BT4ESPET **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.

UNIT - I

1 a) Sujyot has bought an Air Compressor Unit for his Garage. Being a chemical engineer, he understands that the device obeys the law of conservation of energy. Which Thermodynamics law enables him to conclude. With a neat sketch, arrive at the equation for that law. **10**

b) Oil at 500K is to be cooled at a rate of 5000 kg/hr in a counter current exchanger using cold water available at 295 K. A temperature approach of 10 K is to be maintained at both ends of the exchanger. The specific heats of oil and water are 3.2 and 4.2 kJ/kg-K, respectively. Determine the total entropy change in the process. **10**

OR

2 a) A 30 kg steel ball at 427 °C is dropped in 150 kg of oil at 27 °C. The specific heat of steel and oil are 0.5 kJ/kg K and 2.5 kJ/kg K, respectively. Estimate the entropy change of steel, the oil and that of system containing the steel and oil. **10**

b) Define the following with an example each
(i) Closed system (ii) open system (iii) isolated system (iv) state function (v) path function. **10**

UNIT - II

3 a) With a neat diagram, discuss the PVT behavior of pure fluids. **10**

b) Calculate the volume occupied by one mole of oxygen at 300 K and 100 bar using Vander Walls equation. Take a= 0.1378 Nm^4/mol^2 and b= $3.18X10^{-5}$ m^3/mol. **05**

c) Define compressibility factor. Explain the principle of corresponding states with example. **05**

UNIT - III

4 a) With suitable examples, explain about the reference properties, energy properties and derived properties. **06**

b) With a suitable equation, brief about fugacity and fugacity coefficient. Discuss the effect of temperature and pressure on fugacity. **06**

c) Prove that $Cp-C_V=\beta^2VT/k$ **08**

OR

5 a) Explain the physical meaning of partial molar property with neat graph. **10**

b) Some unmeasurable quantities appear in thermodynamic Equations. As a biotech engineer how can you replace such quantities with measurable quantities? Derive the equations containing both unmeasurable and measurable quantities. **10**

UNIT - IV

6 a) Explain the criteria of phase equilibrium. **08**

b) Define activity. Using the concept of activity, explain in detail about the effect of pressure & temperature on activity. **06**

c) Differentiate between ideal and non-ideal solutions with a neat graph. **06**

UNIT - V

7 a) With a neat graph, arrive at an equation for standard free energy change. **10**

b) *n*-Butane is isomerized to *i*-butane by the action of catalyst at moderate temperatures. It is found that the equilibrium is attained at the following compositions. **10**

Temperature (K)	Mol % of *n*-butane
317	31
391	43

Assuming that activities are equal to the mole fractions, calculate the standard free energy of the reaction at 317 K and 391 K and the average value of heat of reaction over this temperature range.

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