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Question Paper Code: R4C02

B.E./B.Tech. DEGREE EXAMINATION, NOV 2025

Fourth Semester

Biotechnology

R21UBT402 - APPLIED THERMODYNAMICS FOR BIOTECHNOLOGISTS

(Regulations R2021)

Duration: Three hours

Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 2 = 20 Marks)

1. State the zeroth law of thermodynamics. CO1- U
2. Differentiate state and path function. CO3- App
3. Define partial molar property. CO1- U
4. A beaker contains 1L of water and another beaker contains 1L of ethanol. To each of the beakers 100ml of water is added. Will the volume of the contents in the beaker increase or decrease? Justify your answer. CO4- App
5. Identify the problems encountered during the formation of phase equilibrium. CO2- U
6. State Gibb's phase rule. CO2- U
7. List the criteria for chemical reaction equilibria. CO2- U
8. Identify the effect of temperature on equilibrium constant. CO2- U
9. Identify the phases of microbial growth. CO1- U
10. Calculate the molecular weight of $C_{0.44}H_{0.86}N_{0.27}$ CO3- App

PART – B (5 x 16= 80 Marks)

11. (a) Derive the steady state flow energy equation and analyze its application in boilers, condensers and turbines. CO4- App (16)
Or
(b) Considering the first law of thermodynamics for a non-flow process, derive the Maxwell's equations. CO3- App (16)
12. (a) Derive an expression for finding activity of a solution, explaining in detail about the escaping tendency of molecules and the effect of pressure on the same. CO3- App (16)

Or

- (b) Derive an expression for measuring the fletness of a binary solution and explain the Lewis-Randall rule. CO3- App (16)

13. (a) Predict the criteria's for achieving phase equilibrium in a binary system and illustrate the vapor-liquid equilibrium. CO3- App (16)

Or

- (b) Sketch the ternary triangular coordinates and compare it with the binary liquid-liquid equilibrium CO4- App (16)

14. (a) Explain the role of equilibrium constant in carrying out any chemical reaction and highlight the effect of temperature on the same. CO1- U (16)

Or

- (b) Summarize the methods for evaluation of equilibrium constants. CO2- U (16)

15. (a) Elucidate the Microbial growth curve and the thermodynamics involved while cultivating microorganisms in a reactor. CO3- App (16)

Or

- (b) Assume that experimental measurements for a certain organism have shown that cells can convert two-thirds (wt/wt) of the substrate carbon to biomass. Calculate the stoichiometric coefficients, yield coefficients $Y_{X/S}$ (g dw cell/g substrate) and Y_{X/O_2} for the following reaction: CO3- App (16)

