Reg.No.:												

VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
[AUTONOMOUS INSTITUTION AFFILIATED TO ANNA UNIVERSITY, CHENNAI]
Elayampalayam – 637 205, Tiruchengode, Namakkal Dt., Tamil Nadu.

Question Paper Code: 90018

B.E. / B.Tech. DEGREE END-SEMESTER EXAMINATIONS – NOV. / DEC. 2024
Third Semester
Biotechnology
U23BT304 – THERMODYNAMICS FOR BIOTECHNOLOGISTS
(Regulation 2023)

Time: Three Hours Maximum: 100 Marks

Answer ALL the questions

Knowledge Levels (KL)	K1 – Remembering	K3 – Applying	K5 - Evaluating
	K2 – Understanding	K4 – Analyzing	K6 - Creating

PART – A

(10 x 2 = 20 Marks)

Q.No.	Questions	Marks	KL	CO
1.	What are the limitations of first law of thermodynamics?	2	K1	CO1
2.	When does the chemical reaction attain equilibrium?	2	K2	CO1
3.	Define partial molar volume.	2	K1	CO2
4.	Explain the term activity.	2	K1	CO2
5.	What is the effect of temperature on heat capacity?	2	K2	CO3
6.	Define standard heat of formation.	2	K1	CO3
7.	What is the importance of Maxwell's equations in establishing relationships between thermodynamic properties?	2	K2	CO4
8.	State the practical limitations of a Carnot cycle for refrigeration.	2	K1	CO4
9.	How is specific growth rate is calculated?	2	K1	CO5
10.	Define degree of reduction.	2	K1	CO5

PART – B

(5 x 13 = 65 Marks)

Q.No.		Questions	Marks	KL	CO
11.	a)	Explain from fundamentals, the first law of thermodynamics for flow process.	13	K1	CO1

(OR)

	b)	What are different types of thermodynamic diagrams? Explain the method of construction of any two thermodynamic diagrams.	13	K1	CO1
12.	a)	i. Explain the methods by which fugacity for a pure component is calculated.	6	K2	CO2
		ii. Derive an expression for fugacity and fugacity coefficient of pure species.	7		
		(OR)			
	b)	Discuss the importance of Gibbs-Duhem equation. Explain its various forms and the applications of Gibbs-Duhem equation.	13	K2	CO2
13.	a)	i. Analyse the temperature dependence of standard heat of reaction.	8	K4	CO3
		ii. Calculate the standard heat of reaction at 298 K for the following reaction: $4\ HCl\ (g) + O_2\ (g) \rightarrow 2\ H_2O\ (g) + 2\ Cl_2\ (g)$ The standard heats of formation are -92.307 kJ/mol for HCl (g) and -241.818 kJ /mol for H_2O (g).	5	K4	
		(OR)			
	b)	i. Explain the temperature dependence of heat capacity.	8	K4	CO3
		ii. Calculate the heat of combustion of methane at 800 K given that the heat of combustion at 298 K is -802.861 kJ/mol and the mean heat capacity in the temperature range from 298 K to 800 K are 41.868 J/mol.K, 30.563 J/mol.K, 41.449 J/mol.K and 34.332 J/mol.K for methane, oxygen, CO_2 and water vapour respectively.	5	K4	
14.	a)	Derive Maxwell equations and also mention the applications.	13	K3	CO4
		(OR)			
	b)	Explain the Carnot principle with a diagram. Which is the more effective way to increase the thermal efficiency of a Carnot engine?	13	K3	CO4
15.	a)	Discuss in detail about the Oxygen requirement and Heat generation in the aerobic growth.	13	K2	CO5
		(OR)			
	b)	Explain in detail about calculation of the electron donor needed for anabolism using the balance of degree of reduction.	13	K2	CO5

PART – C

(1 x 15 = 15Marks)

Q.No.		Questions	Marks	KL	CO
16.	a)	Derive the expressions for the effect of temperature and pressure on activity coefficient.	15	K3	CO2
		(OR)			
	b)	Discuss about the thermodynamics of microbial growth stoichiometry.	15	K2	CO5