Seat No.: _____  Enrolment No. 

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–III (NEW) EXAMINATION – SUMMER 2019**

**Subject Code: 2132102** **Date: 07/06/2019**

**Subject Name:Metallurgical Thermodynamics**

**Time: 02:30 PM TO 05:00 PM** **Total Marks: 70**

**Instructions:**

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

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| **Q.1** | **(a)** | What is Thermodynamics? Give importance of it. | **03** |
| | **(b)** | Explain different kinds of systems in thermodynamics. | **04** |
| | **(c)** | What is thermodynamic equilibrium? Compare extensive and intensive properties. | **07** |
| **Q.2** | **(a)** | Explain energy is a state property. | **03** |
| | **(b)** | State & Define 1st law of Thermodynamics & its significance. | **04** |
| | **(c)** | Justify: $C_p > C_v$. | **07** |
| | | **OR** | |
| | **(c)** | Compare and contrast Hess' law and Kirchhoff's law. | **07** |
| **Q.3** | **(a)** | What is heat capacity? And derive 1st law thermodynamics in terms of Enthalpy. | **03** |
| | **(b)** | Calculate standard enthalpy change for the given reaction at 473 K. $CO_{(g)} + 1/2\ O_{2(g)} = CO_{2(g)}$. Given that standard enthalpy change of formation at 298 K EW -111kJ/mol for $CO_{(g)}$ and -394 kJ/mol for $CO_{2(g)}$. Molar heat capacity of $C_p$ is as follows. For $CO_{(g)}$ =30.0 + 0.0041 T J/K.mol, $O_{2(g)}$ =28.5 + 0.0042 T J/K.mol, $CO_{2(g)}$= 44.2 + 0.0088 T J/K.mol. | **04** |
| | **(c)** | Derive combined expression of 1st and 2nd law of thermodynamics in terms of internal energy, enthalpy, Helmholtz free energy and Gibb's free energy. | **07** |
| | | **OR** | |
| **Q.3** | **(a)** | Iron melts at 1536 °C at 1 atmospheric pressure and its heat of fusion is 14 kJ/mol. This is reversible process at constant temperature and pressure. Calculate the change of entropy at melting point of Iron | **03** |
| | **(b)** | Calculate standard free energy change of reaction: $Ni_{(S)} + 1/2\ O_{2(g)} = NiO_{(S)}$. At 600 K from following data:$\Delta H_{298,NiO(S)}$=-240.6 KJ/mol, $S°_{298,Ni(S)}$= 29.8 J/K/mol, $S°_{298,NiO(S)}$ = 38.1 J/K/mol, $S°_{298,O2(g)}$ = 206 J/K/mol. $C_{p,Ni(S)}$=25.23 + 43.7 *$10^{-6}$ $T^2$ – $10^{-3}$ T J/K/mol. $C_{p,O2(g)}$= 30 + 4.2 * $10^{-3}$ T -1.67 * $10^{-5}$ $T^2$ J/K/mol, $C_{p,NiO(S)}$ = 54 J/K/mol. | **04** |
| | **(c)** | Discuss important features of Ellingham diagram. | **07** |
| **Q.4** | **(a)** | Give Maxwell's relations. | **03** |
| | **(b)** | State 0th and 2nd law of thermodynamics. | **04** |
| | **(c)** | Explain Sivert's and Raoult's law. | **07** |
| | | **OR** | |
| **Q.4** | **(a)** | Write formula for Mol fraction and give definition of Molality, Molarity and Normality | **03** |
| | **(b)** | Explain fugacity, activity and mole fraction. | **04** |
| | **(c)** | What is Free Energy? Explain concept of Gibb's Free Energy. | **07** |

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| **Q.5** | **(a)** | Define Atom fraction. Write conversion from weight % to atom % or vice-versa. | **03** |
| | **(b)** | Write a short note on Clausius-Clapeyron equation. | **04** |
| | **(c)** | Derive and explain Gibb's phase rule. | **07** |

**OR**

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|---|---|---|---|
| **Q.5** | **(a)** | Explain the function of slag | **03** |
| | **(b)** | Explain basicity index with suitable example. | **04** |
| | **(c)** | State and explain fugacity and activity. | **07** |

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