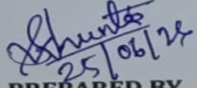


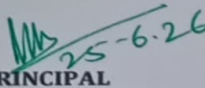
### LESSON PLAN

| LESSON PLAN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |                         |                                                                    |                                                                                                                                         |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------------------|--------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-----|
| Discipline: Metallurgical Engineering                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                 |                         | Semester: 3 <sup>rd</sup> Semester                                 | Name of the Teaching Faculty: Ms. Sitanjali Khuntia                                                                                     |     |
| Subject: Metallurgical thermodynamics & kinetics<br>Sub code: Th-4 (MTPC207)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                 |                         | No of days /Week class allotted:03                                 | Semester from Date: 01/7/2026 to 05/11/2026<br>No of weeks: 21                                                                          |     |
| Course Outcomes:<br>CO1. Demonstrate an understanding of thermodynamic laws and their relevance to metallurgical systems.<br>CO2. Interpret and apply phase diagrams, Ellingham diagrams, and Gibbs free energy concepts in metal processing.<br>CO3. Analyse chemical reaction kinetics and phase transformation mechanisms in metallurgical operations.<br>CO4. Apply electrochemical principles to understand corrosion behaviour and prevention techniques.<br>CO5. Utilize thermodynamic and kinetic principles for optimizing metallurgical and materials engineering processes. |                 |                         |                                                                    |                                                                                                                                         |     |
| Month                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Week            | No of periods available | Class Day                                                          | Theory topics                                                                                                                           | CO  |
| July                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1 <sup>ST</sup> | 1P                      | 01-07-2026                                                         | Basic Concepts of Thermodynamics (10 hours)<br>Introduction: Definition of thermodynamics, system, surroundings,                        | CO1 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 2 <sup>ND</sup> | 3P                      | 06-07-2026                                                         | Types of systems (open, closed, isolated), thermodynamic properties (intensive, extensive), state functions                             | CO1 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                         | 07-07-2026                                                         | Zeroth Law of Thermodynamics: Concept of thermal equilibrium, temperature measurement.                                                  | CO1 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                         | 08-07-2026                                                         | First Law of Thermodynamics: Conservation of energy                                                                                     | CO1 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 3 <sup>RD</sup> | 3P                      | 13-07-2026                                                         | Internal energy, enthalpy,                                                                                                              | CO1 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                         | 14-07-2026                                                         | Heat and work, heat capacity, specific heat. Applications:                                                                              | CO1 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                         | 15-07-2026                                                         | Brief idea about various processes isothermal, adiabatic, isobaric, isochoric.                                                          | CO1 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 4 <sup>TH</sup> | 3P                      | 20-07-2026                                                         | Quiz test                                                                                                                               | CO1 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                         | 21-07-2026                                                         | Second and Third Law of Thermodynamics Entropy: Concept of entropy,                                                                     | CO1 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                         | 22-07-2026                                                         | entropy change in reversible and irreversible processes, entropy and disorder                                                           | CO1 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 5 <sup>TH</sup> | 3P                      | 27-07-2026                                                         | Second Law Statements: Different statements of the second law                                                                           | CO1 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                         | 28-07-2026                                                         | CLASS TEST                                                                                                                              | CO1 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                         | 29-07-2026                                                         | Gibbs free energy: Definition of Gibbs free energy, its significance in determining spontaneity of reactions                            | CO2 |
| Aug                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1 <sup>ST</sup> | 3P                      | 03-08-2026                                                         | Relationship between Gibbs free energy and equilibrium constant.                                                                        | CO3 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                         | 04-08-2026                                                         | Third Law of Thermodynamics, Gibbs free energy ( $\Delta G$ ) & Helmholtz free energy ( $\Delta A$ ), Maxwell relations (No Derivation) | CO2 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                         | 05-08-2026                                                         | Third Law of Thermodynamics, Gibbs free energy ( $\Delta G$ ) & Helmholtz free energy ( $\Delta A$ ), Maxwell relations (No Derivation) | CO2 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 2 <sup>ND</sup> | 3P                      | 10-08-2026                                                         | <i>Solutions &amp; Phase Rule: Ideal &amp; non- ideal solutions,</i>                                                                    | CO2 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                         | 11-08-2026                                                         | <i>Raoult's Law, Henry's Law, Phase rule (Gibbs' phase rule),</i>                                                                       | CO2 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                         | 12-08-2026                                                         | <i>Unary &amp; binary phase diagrams,</i>                                                                                               | CO2 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 3 <sup>RD</sup> | 3P                      | 17-08-2026                                                         | <i>Ellingham Diagrams &amp; Applications, Concept of Ellingham diagrams</i>                                                             | CO2 |
| 18-08-2026                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |                         | <i>Ellingham Diagrams &amp; Applications, Concept of Ellingham</i> | CO2                                                                                                                                     |     |

|      |                 |    |            |                                                                                      |            |
|------|-----------------|----|------------|--------------------------------------------------------------------------------------|------------|
|      |                 |    |            | diagrams                                                                             |            |
|      |                 |    | 19-08-2026 | Oxide stability & reduction reactions, Predominance Area Diagram                     | CO2        |
|      | 4 <sup>TH</sup> | 2P | 24-08-2026 | Oxide stability & reduction reactions, Predominance Area Diagram                     | CO2        |
|      |                 |    | 25-08-2026 | Quiz test                                                                            | CO2        |
|      | 5 <sup>TH</sup> | 1P | 31-08-2026 | Revision & Discussion                                                                | CO2        |
| Sept | 1 <sup>ST</sup> | 2P | 01-09-2026 | 1 <sup>ST</sup> Internal Assessment                                                  | CO1 to CO2 |
|      |                 |    | 02-09-2026 | Fundamentals of Reaction Kinetics: Rate of reaction, order & molecularity,           | CO3        |
|      | 2 <sup>ND</sup> | 3P | 07-09-2026 | Activation energy & Arrhenius equation, Homogeneous vs. Heterogeneous reactions,     | CO3        |
|      |                 |    | 08-09-2026 | Activation energy & Arrhenius equation, Homogeneous vs. Heterogeneous reactions,     | CO3        |
|      |                 |    | 09-09-2026 | Activation energy & Arrhenius equation, Homogeneous vs. Heterogeneous reactions,     | CO3        |
|      | 4 <sup>TH</sup> | 3P | 21-09-2026 | Electrochemical Thermodynamics: Electrochemical cells, Nernst equation (Basic Level) | CO4        |
|      |                 |    | 22-09-2026 | Electrochemical Thermodynamics: Electrochemical cells, Nernst equation (Basic Level) | CO4        |
|      |                 |    | 23-09-2026 | Nernst equation (Basic Level)                                                        | CO4        |
|      | 5 <sup>TH</sup> | 3P | 28-09-2026 | Quiz test                                                                            | CO4        |
|      |                 |    | 29-09-2026 | Revision & Discussion                                                                | CO4        |
|      |                 |    | 30-09-2026 | CLASS TEST                                                                           | CO4        |
| Oct  | 2 <sup>ND</sup> | 3P | 05-10-2026 | Thermodynamics in Metallurgical Processes                                            | CO5        |
|      |                 |    | 06-10-2026 | Thermodynamics in Metallurgical Processes                                            | CO5        |
|      |                 |    | 07-10-2026 | Application of Thermodynamics in Extraction & Refining:                              | CO5        |
|      | 3 <sup>RD</sup> | 3P | 12-10-2026 | Basics of Ironmaking & Steelmaking thermodynamics,                                   | CO5        |
|      |                 |    | 13-10-2026 | Basics of Ironmaking & Steelmaking thermodynamics,                                   | CO5        |
|      |                 |    | 14-10-2026 | Roasting, Smelting,                                                                  | CO5        |
|      | 4 <sup>TH</sup> | 1P | 21-10-2026 | Revision & Discussion                                                                |            |
|      | 5 <sup>TH</sup> | 3P | 26-10-2026 | 2 <sup>nd</sup> Internal Assessment                                                  | CO4 & CO5  |
|      |                 |    | 27-10-2026 | Refining processes,                                                                  | CO5        |
|      |                 |    | 28-10-2026 | Basic Concept of activity, & equilibrium constant                                    | CO5        |
| Nov  | 1 <sup>ST</sup> | 3P | 02-11-2026 | Basic Concept of activity, & equilibrium constant                                    | CO5        |
|      |                 |    | 03-11-2026 | Viva                                                                                 | CO1 to CO5 |
|      |                 |    | 04-11-2026 | Course wrap-up & question bank discussion                                            | CO1 to CO5 |

  
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