MTPC2001 METALLURGICAL THERMODYNAMICS AND KINETICS (3-0-0)

Course Objective:
To understand thedifferent laws and principles of thermodynamics and their applications in metallurgical operation.

Module I
Importance of Thermodynamics, definition of thermodynamic terms; concept of states, simple equilibrium. Equation of states, extensive and intensive properties, homogeneous and heterogeneous systems. Phase diagram of a single component system. Internal energy, heat capacity, enthalpy, isothermal, and adiabatic processes.

Module-II
Second law of thermodynamics, entropy, degree of reversibility and irreversibility, criteria of equilibrium, auxiliary functions, combined statements, Maxwell's relations, transformation formula, Gibbs-Helmoltz equation. Concept of Third law of thermodynamics, temperature dependence of entropy, statistical interpretation of entropy, Debye and Einstein concept of heat capacity, relation between Cp and Cv , consequences of third law.

Module III
Fugacity, activity, equilibrium constant, use of S-functions, controlled atmospheres, homogeneous and heterogeneous equilibria. Ellingham – Richardson diagrams, phase stability diagrams.
Solutions: partial molal quantities, ideal and non-ideal solutions, Henry's law, Gibbs – Duhem equation, regular solution, quasi-chemical approach to solution, statistical treatment. One weight percentage standard state, chemical potential, phase relations and phase rule – its applications.

Module IV
Free energy – composition diagrams for binary alloy systems, determination of liquidus, solidus and solvus lines. Effect of pressure on phase transformation and phase equilibria. Thermodynamics of electrochemical cells, solid electrolytes. Thermodynamics of point defects in solids.

Module V
Introduction to metallurgical kinetics: heterogeneous reaction kinetics: gas-solid, solid – liquid, liquid – liquid and solid-solid systems. Empirical and semi-empirical kinetics, concept of Johnson – Mehl equation, thermal analysis.

Course Outcome:
CO1: To understand the concept and importance of thermodynamics
CO2: To understand and apply the laws of thermodynamics
CO3: To apply the knowledge of thermodynamics in the real engineering world.
CO4: To interpret and apply the data of thermodynamics in the Metallurgical Engineering processes.
CO5: To identify and recommend the optimum operational parameters to be employed in significant Metallurgical Engineering processes.

Text Books:

1. GaskellD.R., Introduction to the Thermodynamics of Materials; Taylor and Francis.
2. GhoshA., Textbook of Materials and Metallurgical Thermodynamics; Prentice Hall of India Pvt. Ltd.

Reference Books:

1. Bose S.K. and Roy S.K., Principles of Metallurgical Thermodynamics; University Press
2. TupkaryR.H.,Essentials of Metallurgical Thermodynamics; Khanna Book Publishing