PMM106: THERMODYNAMICS AND KINETICS OF MATERIALS

L	T	P	Cr
3	1	0	3.5

Course Objective(s): To develop a clear understanding of laws of thermodynamics as they apply to different elements and compounds and their interactions in the solid, liquid, and gaseous forms as a function of various extensive and intensive variables. To analyze the path to thermodynamic equilibrium through studying reaction kinetics and the laws those govern mass transfer in solids. To understand the concept of boundary layer with a specific example of Slag – metal reaction kinetics.

Laws of Thermodynamics: Thermodynamics laws and their applications; Enthalpy; Entropy associated with different processes; Gibbs and Helmholtz free energy; Criteria of equilibrium; Concepts of activity, fugacity and standard states; Ellingham diagram.

Thermodynamics of Solutions: Raoult's and Henry's Laws; Ideal, real and regular solutions; Gibbs – Duhem equation.

Thermodynamics of Electrochemical Cells: Relationship between chemical and electrical driving forces, Nernst equation, concentration and formation of cells.

Free Energy Composition Diagram: Fundamentals of free energy composition diagrams for binary systems. Examples of common binary free energy diagrams.

Kinetics: Activation energy and its applications; Homogeneous and heterogeneous reactions; Factors affecting the heterogeneous reactions kinetics in solid – solid, solid – gas and solid – liquid systems; Rate controlling steps; Kinetic model equations.

Slag – Metal Reaction Kinetics: Concept of boundary layer and its impact on reaction kinetics.

Course Learning Outcomes (CLO):
Students will be able to:

1. Understand of thermodynamics and kinetics involved in materials and processes;
2. Predict whether a reaction or a process would occur and if yes, how fast or slow a process would be;
3. Explain how to overcome the energy barrier to accomplish the transformation from the starting state to the final state, i.e., analyze the feasibility and efficiency of a materials processing technology.

Recommended Books:

1. *Gaskell D.R., Introduction to Metallurgical Thermodynamics, McGraw Hill, New York, (1973).*
2. *Upadhyay G.S. and Dubey R.K., Problems in Metallurgical Thermodynamics and Kinetics, Pergamon, New York, (1977).*
3. *Szekely J. and Themelis N.J., Rate Phenomena in Process Metallurgy, John Wiley, New York (2002)*
4. *Mohanty A.K., Rate Processes in Extractive Metallurgy, Prentice Hall of India (2002).*