Course Title: Phase Diagrams for Material Synthesis

Course Code: CH-821

Credit Hours: 3-0

Prerequisite: Nil

Course Objectives

The objectives of “Phase Diagrams” course are to; explain the principles of Phase Equilibria and Phase Rules that allow the interpretation and experimental construction of phase diagrams in terms of thermodynamic relations. Extended objective also includes the explanation of the solid solubility, equilibrated and non-equilibrium alloys, microstructures and their effects on material properties in unary, binary and ternary systems.

Course Outcomes

After completion of this course, students will be able to demonstrate the knowledge of:

a. Interpretation and experimental construction of Unary, binary and ternary phase diagrams.
b. Microstructure and physical property relation.
c. Eutectic, Peritectic, Eutectoid, Peritectoid, Monotectic etc,. reactions.
d. Material synthesis according properties of choice.

Course Contents

Introduction to fundamental concepts (Phase, Crystal structure, solid solubility, composition, equilibrium).

Thermodynamic fundamentals and introduction to phase diagrams. Phase Rule, Lever Rule. Numerical Practice. Continuous solid solutions and eutectics. Hume-Rothery rules, Intermediate phases.

Binary Phase Diagrams: Different *Binary Systems; Eutectic, Eutectoid, Peritectic, peritectoid, Monotectic, Syntectic etc.* With Example Practice

Two phase equilibria; the enthalpy and entropy of mixing; the regular solution model.

Derivation of phase diagrams using free energy - composition curves. Scheil equations. Nucleation and growth of a new phase.

Ternary phase diagrams: Gibbs triangle, vertical and isothermal sections, Concept of tie lines, rules for construction of tie lines,, concept of tie-triangle. Multi-component alloy systems: Stainless steels, high speed steels, super alloys, light metal alloys, refractory systems.

Synthesis and characterization of alloys in relation to phase rules equilibria. Example case studies.

Ternary phase diagrams: Gibbs triangle, vertical and isothermal sections, Concept of the lines, rules for construction of tie lines, three phase equilibrium, concept of tie-triangle. Multi-component alloy systems: Stainless steels, high speed steels, super alloys, light metal alloys, refractory systems.

Recommended Books

1. Ji-Cheng Zhao, Methods for Phase Diagram Determination, Elsevier Science, ISBN: 9780080549965, ISBN: 9780080446295, 2007.
2. M.A. Clevinger, Phase Equilibria Diagrams The American Ceramic Society, Inc, 1996
3. D.R. Gaskell, Introduction to Metallurgical Thermodynamics, McGraw-Hill, 1980