

Physico-chemical principles of steel making; slag metal equilibrium involved in steel making. Ionic slag theory as applied to slag-metal reaction in hearth steel making; role of slag –metal and gas metal reaction in pneumatic steel melting processes.

Genesis of modern combine blowing technique of steel production. Refining mechanism in oxygen steel making process. Electric arc furnace steel making for high alloy steels.

De-oxidation, degasification and decarburization-different techniques of vacuum degassing, AOD, VOD, CLU and MRP processes.

References:

1. Physical Chemistry of Iron and Steel Manufacture, Author- C. Bodsworth
2. Making ,Shaping and Treating of Steel.
3. Ferrous Process Metallurgy, Author- J.L. Bray
4. An Introduction to Physical Chemistry of Iron and Steel Making, Author- R.G.Ward
5. The Physical Chemistry of Liquid Steel in Electric Furnace Steelmaking, Author- J.F Elliot
6. Iron Making And Steel Making- Theory and Practice, Author – A. Ghosh and A. Chattrjee.

MTT-653 STRUCTURAL METALLURGY OF FERROUS MATERIALS 2L-1T-0P/3Cr

Introduction: Classification of ferrous alloys; steel, cast iron and other carbon less ferrous alloys.

Theory of diffusional decomposition of austenite; nucleation and growth processes; thermodynamics and kinetics. Transformation kinetics – Johnson –Mehl equation. Discontinuous precipitation in austenite –theory of pearlite transformation. Effect of transformation temperature on the products of diffusional decomposition of austenite. Mechanism of widmanstatten ferrite formation in steel. Massive transformation in steel.

Theory of bainitic transformation. Diffusionless transformation of austenite; formation of martensite in steel .Theoretical aspects of evolution of microstructures and their stability under the influence of non-equilibrium cooling.

References:

1. Physical Metallurgy of Iron and Steels, Author - Rajendrakumar; Asia publication 1968
2. Theoretical Structural Metallurgy, Author - A.H. Cottrell.
3. Phase Transformation in Condensed system, Author - Morris Fine
4. Modern Physical Metallurgy and Materials Engineering, Author- R.E.Smallman, R.J Bishop
5. Phase Transformation in Metals and Alloys, Author-D.A .Porter.
6. Bainite in Steels, Author - H.K Bhadeshia.

MTT-655ADVANCED SOLIDIFICATION PROCESSING OF STEELS 2L-1T-0P/3Cr

Nucleation in pure metal; growth of a pure solid- spiral growth, heat flow and interface stability; formation of dendrites.Solidification of alloys – constitutional super-cooling; cellular solidification in ferrous materials.Peritectic solidification in steels;peritectic wall.Solidification of low, medium carbon and high carbon steel ingots and castings. Structure of ingots; formation of columnar zone, segregation in steel ingots and steel castings; feeder design in steel casting;Continuous casting of steel; casting practice of stainless steel, high speed steel, Hadfield manganese steel.

References:

1. Solidification Processing, Author - M.C.Flemings
2. Physical Metallurgy Principles, Author - R.Reed-Hill.
3. Metal Casting Principle, Author - Heine and Rosenthal
4. ASM Metal Hand Book, Casting Vol. 15

Physical metallurgy of alloy tool steels of different varieties. Microstructural variation with heat treatment and its impact on properties and application of steels such as cold work tool steel, hot work tool steels, water hardening tool steels, shock-resisting tool steels, and high speed steels.

Physical metallurgy of stainless steels and their classification.

Embrittlement in ferritic stainless steel, sensitization and stabilization in austenitic stainless steel; stabilized austenitic alloys. Physical metallurgy of Inconel, and A286 with their specific applications.

Strengthening mechanisms for and influence of reverted austenite on the properties of maraging steels.

References:

1. Physical Metallurgy of steels, Author - W.C. Leslie
2. Physical Metallurgy, Vol.I , Author - R. W. Cahn
3. Tool Steels, Author - Roberts and Cary
4. Physical Metallurgy of Microalloyed Steels, Author – T.Gladman.
5. Thermomechanical Treatment of steels, Author – Tanaka

Continuum Plasticity in Steels

True Stress – true Strain, Necking Criterion. Plastic stress-strain relations. Phenomenological aspects of severe plastic deformation.

Microstructural Aspects of Plasticity

Theoretical shear strength; Elements of dislocation theory as applied to mechanical behavior of steels. Crystallography of slip and Independent Slip Systems, Slip Plane relation, Twinning in steels.

Strengthening Mechanisms in steels

Work Hardening, Grain boundary strengthening, Solid Solution Strengthening, Point defect-dislocation interactions, Yield point phenomenon, Precipitation hardening, dislocation-precipitate interactions, and ordered hardening.

Fatigue in steels

Fatigue, Fatigue crack initiation, Fatigue crack growth, Different stages of fatigue crack growth, Paris law and models, Threshold, Damage tolerant approach, Striations, Ultra high cycle fatigue in steels.

Creep Behavior of steels: Time dependent deformation-creep, different stages of creep, creep and stress rupture, use of creep data, Larsen-Miller parameter, creep mechanisms and creep mechanism maps, creep under multi-axial loading, microstructural aspects of creep.

References:

1. Mechanical Metallurgy, Author - George E. Dieter
2. Plastic deformation in metals, Author - R.W.K Honeycombe
3. Dislocations in metallurgy, vol 4, Author: F.R.N. Nabarro
4. Mechanical Behaviour and Testing of Materials, Author - A. K. Bhargava and C.P. Sharma, PHI Learning Pvt. Ltd. N. Delhi.
5. Dislocations and Mechanical Behaviour of Materials, Author - M.N. Shetty, PHI