

Design rationales of steels for various engineering applications. Factors influencing the design of steels. Microstructural aspects of steel for use at low temperatures, high temperatures, and under corrosive atmosphere. Development of steels for high strength, and high toughness applications requiring high ballistic properties. Development strategies for cryogenic steels, creep resistant steels. Design of steels for wear resistant applications. Development of high performance steels e.g. TRIP steel and TWIP steels, interstitial free steels, nitrogen steels and extra low carbon precipitation hardenable steels.

**References**

1. Steels: Microstructure and Properties, Author- R.W.K.Honeycombe
2. Principles of Heat Treatment of Steels, Author-G.Krauss
3. Ferrous Physical Metallurgy, Author –A.K Sinha
4. Steels -Metallurgy and Application, Author-D.T.LLewellyh and R.C Hudd
5. Physical Metallurgy and Design of Steels, Author-F.B.Pickering, App. Sc. publication
6. Steels- Processing , Structure and Performance, Author –George Krauss
7. Advanced steels-The recent Scenario in Steels Science & Technology, Author- Y.Weng, H.Dong .

Introduction to secondary steel technology. DRI as feed material to secondary steel making. Emerging and non-conventional DRI techniques; recent modifications in secondary steel technology. Ultra high power electric arc furnace steel making practice; Ajax process; IRSID process; SIP process and dual hearth furnace technology.

Production of clean steel through secondary steel technology route. Synthetic slag practice-its possible application in induction furnace. Ladle metallurgy, electro slag refining process, CEVAM process. Usefulness of injection metallurgies.

**References:**

1. Secondary Steel Making - principles and application, Author- A.Ghosh
2. Steel Making, Author -A.K.Chakraborty
3. Ladle Metallurgy Practice, Iron and Steel Soc.1985, Author – R.J Fruehan

## **MTT-656 STRUCTURAL INTEGRITY AND RESIDUAL LIFE ASSESMENT 2L-1T-0P/3Cr**

Failure in steel components,- its modalities; review of elements of fracture mechanics-  
Influence of microstructures on time dependent failures in steels viz. fatigue, creep and stress  
corrosion.

Assessment of integrity by nondestructive testing viz. Ultrasonic, X-Ray and Gamma-Ray  
radioscopy, Acoustic Emission Techniques, Eddy Current Testing etc. Fractographic  
Analysis, Interpretation of common optical, scanning electron and transmission electron  
metallographs.

### **References:**

1. Elementary Engineering Fracture Mechanics, Author - David Broeh
2. Failure Analysis Case Studies. Author – D.R.H. Jones
3. Physical Metallurgy Vol.3, (Mechanical Behavior), Author - R.W. Cahn

## **MTT-658 Characterization of Engineering Materials**

**2L - 1T - 0P /3Cr**

Review of optical metallography. Determination of grain size, determination of volume fractions of various phases in microstructure.

Principles and operation of scanning electron microscopy, contrast theory, secondary electron and back scattered electron image in SEM.

Atomic force microscopy and scanning tunneling microscopy.

X-ray diffraction, scattering of X-rays by an electron, an atom and a unit cell. Structure factor, Lorentz-polarization factor. Intensity of diffracted X-Ray beam—it's experimental measurement. Use of X-ray Diffraction for structure analysis, particle size determination, determination of residual stresses.

Principles of transmission electron microscopy. Theory of contrast in TEM, Energy dispersive analysis, Auger electron microscopy. Theory of diffraction---selected area diffraction pattern (SADP) in TEM, indexing of SADPattern.

**Spectroscopy:** X-ray fluorescence, infrared spectroscopy, and Raman spectroscopy.

**Electron Probe Microanalysis:** Principle and applications.

Differential mechanical analysis. Thermal analysis of materials-----DSC, DTA for phase transformation study.

Differential dilatometry and resistivity analysis for phase transformation characterization.

### **References:**

1. Transmission Electron Microscopy – G. Thomas
2. Elements of X-ray Diffraction – B.D. Cullity
3. Materials Characterisation Techniques – S. Zhang, Lin Li and Ashok Kumar
4. Characterisation of Materials – E. N. Kaufmann
5. Electron Diffraction – J.W. Eddington

## **MTT-660 FRONTIERS OF MECHANICAL WORKING OF STEELS 2L-1T-0P/3Cr**

Classification of metal working process- primary and secondary processes.Mechanics of metal working.Deformation physics and damage mechanics.

Advances in controlled rolling and controlled forging of steels.Forging force and friction.

Powder rolling and powder forging.

Extrusion and wire drawing- impact of strain rate.Deep drawing and sheet metal forming.

Explosive forming.Forming at high strain rate-its impact on structure and properties.

Severe plastic deformation of materials and genesis of ultra fine grained materials.

### **References:**

1. ASM Metals Handbook, Vol.14, Forming, Forging and Casting
2. Mechanical Metallurgy, Author: George E.Dieter
3. Relevant journal materials on SPD, HEF (review papers from Int. Mat. Rev.

**MTT-662 ENVIRONMENT & WASTE MANAGEMENT IN STEEL INDUSTRIES**

**2L-1T-0P/3Cr**

Classification and Types of Ferrous Industries, Types of Solid Waste, Liquid Effluents, Air Pollutants and their Classification, Sources of Emission, Impact of Major Emissions on Environment, Utilization and Management of Waste, Air Pollution Abatement Devices, Various Hazards in steel Industry, Brief idea about Environmental Laws in India, Environmental Management Systems.

**References:**

1. Energy and Environmental Management in Metallurgical Industries, Author: R.C. Gupta, PHI, 2012
2. Environmental Pollution Control Engineering, Author: C.S. Rao, Willey Estern Ltd., New Delhi.
3. Environmental and Waste Management in Metallurgical Industries, Ed. A. Bandhopadhyay, N.G. Goswami and P.R. Rao, NML, Jamshedpur, 1996.

Heat flow in welding. Solidification fusion welds - influence of welding speed on microstructure of steels. Fundamentals of welding of steels ; Heat affected zone .Modern trends in welding viz Laser beam welding ; Diffusion welding of steel with dissimilar alloys ; Plasma MIG welding , High frequency welding, Electron beam welding and Electro slag welding. Influence of welding on the steel, weldmet soundness; weld decay in austenitic steel and its remedial measures.

Structural degradation due to welding of steel and its remedies.

References:

1. ASM Metal Hand Book: Welding, Brazing and Soldering
2. Welding Technology, S.R. Parmar

Introduction to steels as constructional, structural and special purpose material.

Properties requirements for structural steels. Factors affecting the properties of structural steels.

Relative merits and demerits of low carbon, medium carbon and high carbon steels as structural material.

Relative merits and demerits of low alloy steels and high alloy steels as structural material.

Steels suitable for structural applications. Steels for making springs, bearings, gears, crankshafts, pistons, rolls, high tensile nuts and bolts.

Steels suitable for power generating machines and devices.

Steels suitable for aircraft structural parts.

References:

1. Metals Hand book, Volume 1.