

Lecture 1 - Module 1 : Lecture 1 - Solution models

Lecture 2 - Module 1 : Lecture 2 - Summary of solution models

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Lecture 5 - Module 1 : Lecture 5 - Bond breaking model

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Lecture 21 - Module 3 : Lecture 15 - Regions of stability

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- Lecture 85 - Module 21 : Lecture 78 - Grain boundary grooving - I
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Lecture 9 - R:Demos and getting help

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Lecture 11 - R as calculator and plotter: Diffraction, configurational entropy

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Lecture 13 - Tabular data in R: alternate methodology

Lecture 14 - Dataframe in R: Properties of elements

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Lecture 16 - Importing and plotting data

Lecture 17 - Property charts: Importing and plotting data

Lecture 18 - Introduction to R: Summary of the module

Lecture 19 - Descriptive statistics

Lecture 20 - Presenting experimental results: Data on conductivity of ETP copper

Lecture 21 - Property based reports, errors, significant digits

Lecture 22 - Dealing with distributions: Grain size data

Lecture 23 - Grain size data: Property and rank based reports

Lecture 24 - Case study: Grain size in a two phase steel

Lecture 25 - Grain size in a two phase steel: Descriptive statistics

Lecture 26 - Presenting experimental results: data with error bars

Lecture 27 - Errors and their propagation

Lecture 28 - Fitting experimental data to distributions

Lecture 29 - Combining uncertainties

Lecture 30 - Summary:Descriptive statistics

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- Lecture 62 - Estimating mean and mean-square-deviation of data
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- Lecture 65 - From data to underlying distribution
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- Lecture 77 - Data of known functional form
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- Lecture 80 - Summary:Fitting and graphical handling of data
- Lecture 81 - Regression Analysis - I
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- Lecture 83 - Regression Analysis - III
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- Lecture 92 - Case studies: Introduction
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Lecture 3 - Can we predict if a metal corrodes? - Part II

Lecture 4 - Can we calculate the rate of corrosion: Electrochemical kinetics - Tafel relation?

Lecture 5 - Can we calculate the rate of corrosion: Electrochemical kinetics - diffusion and mixed potential theory?

Lecture 6 - Can we calculate the corrosion rate of metals: Mixed potential theory and passivity?

Lecture 7 - Passivity (Continued...)

Lecture 8 - DC polarisation experiments and their relation to mixed potential theory/Evans diagram

Lecture 9 - Pourbaix diagram and electrochemical corrosion

Lecture 10 - Forms of corrosion: Uniform v/s localised corrosion

Lecture 11 - Forms of corrosion: Factors affecting uniform corrosion

Lecture 12 - Forms of corrosion: Preventive measures for uniform corrosion - Part I

Lecture 13 - Forms of corrosion: Preventive measures for uniform corrosion - Part II

Lecture 14 - Forms of corrosion: Galvanic or dissimilar metal corrosion - Part I

Lecture 15 - Forms of corrosion: Galvanic or dissimilar metal corrosion - Part II

Lecture 16 - Forms of corrosion: Galvanic or dissimilar metal corrosion - Part III

Lecture 17 - Forms of corrosion: Crevice corrosion - Part I

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Lecture 27 - Forms of corrosion: Erosion corrosion - Part II

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- Lecture 2 - External corrosion of pipelines
- Lecture 3 - Electrochemical principles
- Lecture 4 - Criteria
- Lecture 5 - Assessment of pipeline condition through surveys - Part I
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- Lecture 7 - Anode ground bed for cathodic protection
- Lecture 8 - Perspectives in storage tanks and off-shore structures
- Lecture 9 - Anodes
- Lecture 10 - Worked out examples
- Lecture 11 - Stray current corrosion and its control
- Lecture 12 - Coatings and rectifier selection
- Lecture 13 - Internal corrosion of oil and steel gas pipelines
- Lecture 14 - Anodic protection engineering

Lecture 1 - Introduction

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Lecture 3 - Unit cell

Lecture 4 - Classification of lattices

Lecture 5 - Gaps in Bravais lattice list

Lecture 6 - Symmetry - I

Lecture 7 - Symmetry - II

Lecture 8 - Classification of lattices on the basis of symmetry

Lecture 9 - A symmetry based approach to Bravais lattices

Lecture 10 - Miller indices of directions

Lecture 11 - Miller indices for planes

Lecture 12 - Miller indices for plane and its normal in Cubic Crystal

Lecture 13 - Weiss Zone law and its applications

Lecture 14 - Inter-planar spacing

Lecture 15 - Bragg's Law

Lecture 16 - Close-packing of hard spheres

Lecture 17 - Hexagonal Close-Packed (HCP) structure

Lecture 18 - Lattice and motif of HCP crystals

Lecture 19 - c/a ratio of an ideal HCP crystal

Lecture 20 - ABCABC stacking of close-packed spheres

Lecture 21 - Voids in close-packed structures

Lecture 22 - Solid solutions - I

Lecture 23 - Solid solutions - II

Lecture 24 - Hume-Rothery rules

Lecture 25 - Ordered and disordered solid solutions

Lecture 26 - Graphene

Lecture 27 - Structure of graphite

Lecture 28 - Structure of diamond

Lecture 29 - Carbon nanotubes (CNT)

Lecture 30 - Buckminsterfullerene (C60)

Lecture 31 - Ionic solids

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Lecture 45 - Edge dislocation: Half plane

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Lecture 48 - Edge, screw and mixed dislocations

Lecture 49 - Screw dislocations

Lecture 50 - Burgers circuit

Lecture 51 - Elastic energy of a dislocation line

Lecture 52 - Burgers vector: Shortest lattice translation

Lecture 53 - Burgers vector of a dislocation is constant along the line

Lecture 54 - Geometrical properties of a dislocations: Dislocation cannot end abruptly in a crystal: Free surface

Lecture 55 - Dislocation cannot end abruptly in a crystal: Grain boundaries

Lecture 56 - Dislocation cannot end abruptly in a crystal: Dislocation nodes

Lecture 57 - Dislocation cannot end abruptly in a crystal: Dislocation loop

Lecture 58 - Dislocation motion

Lecture 59 - 2D defects: Surfaces or interfaces

Lecture 60 - Free surface or external surface of the crystal

Lecture 61 - Stacking faults

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Lecture 65 - Ball bearing model

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Lecture 70 - Composition of phases present in the system

Lecture 71 - Proportion of phases present in the system

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Lecture 74 - Eutectic reaction

Lecture 75 - Eutectic, hypoeutectic and hypereutectic alloys

Lecture 76 - Gibbs's phase rule

Lecture 77 - Fe-C phase diagram

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- Lecture 103 - TTT diagram of alloy steel
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- Lecture 119 - Dislocation interaction leading to strain hardening - I
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**NPTEL : Electroceramics (Metallurgy and Material Science)**

**Co-ordinators : Dr. Ashish Garg**

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**NPTEL : Fuels Refractory and Furnaces (Metallurgy and Material Science)**

**Co-ordinators : Prof. Satish Ch. Koria**

Lecture 1 - Energy Resources and Environment

Lecture 2 - Characterization of Fuels: Concepts

Lecture 3 - Characterization of Fuels: Concepts

Lecture 4 - Production of Secondary Fuels : Carbonization

Lecture 5 - Materials Balance in Coke-making

Lecture 6 - Heat Balance and Clean Development Mechanism

Lecture 7 - Production of Secondary Fuels: Gasification

Lecture 8 - Materials and Heat Balance in Gasification

Lecture 9 - Principles of combustion: Concepts and illustrations

Lecture 10 - Principles of combustion: Concepts and illustrations

Lecture 11 - Materials balance in combustion

Lecture 12 - Principles of Combustion: Flame Temperature

Lecture 13 - Flame Temperature Calculations

Lecture 14 - Refractory in Furnaces

Lecture 15 - Refractory in Furnaces

Lecture 16 - Furnace: Types and Classification

Lecture 17 - Heat Utilization in furnaces, energy flow diagrams

Lecture 18 - Heat Utilization in furnaces, energy flow diagrams

Lecture 19 - Heat Utilization in Furnaces: Heat Recovery Concepts and Illustrations

Lecture 20 - Heat Utilization in Furnaces: Heat Recovery Concepts and Illustrations

Lecture 21 - Transport Phenomena in Furnaces: Fluid Flow

Lecture 22 - Macroscopic Energy Balance: Concepts

Lecture 23 - Macroscopic Energy Balance: Applications to Design Head Meters, Stack and Blowers, Types of Flames

Lecture 24 - Macroscopic Energy Balance: Applications to Design Head Meters, Stack and Blowers, Types of Flames

Lecture 25 - Macroscopic Energy Balance: Applications to Design Head Meters, Stack and Blowers, Types of Flames

Lecture 26 - Macroscopic Energy Balance: Applications to Design Head Meters, Stack and Blowers, Types of Flames

Lecture 27 - Principles of Burner Design

Lecture 28 - Transport Phenomena in Furnaces: Heat Transfer and Refractory Design

Lecture 29 - Transport Phenomena in Furnaces: Heat Transfer and Refractory Design

Lecture 30 - Transport Phenomena in Furnaces: Convection and Radiation Heat Transfer, Role of Refractory

Lecture 31 - Transport Phenomena in Furnaces: Convection and Radiation Heat Transfer, Role of Refractory

[Lecture 32 - Steady Heat flows in Furnace and Heat Exchanger](#)

[Lecture 33 - Exercises on Heat Flow in Furnaces and Heat Exchangers](#)

[Lecture 34 - Exercises on Heat Flow in Furnaces and Heat Exchangers](#)

[Lecture 35 - Miscellaneous Topics: Atmosphere in Furnaces](#)

[Lecture 36 - Miscellaneous Topics: Pyrometry](#)

[Lecture 37 - Miscellaneous Topics: Pyrometry](#)

[Lecture 38 - Miscellaneous topics: Electric Resistance Heating](#)

[Lecture 39 - Furnace efficiency, Fuel Saving, Carbon Offset: Concepts and Exercises](#)

[Lecture 40 - Furnace efficiency, Fuel Saving, Carbon Offset: Concepts and Exercises](#)

**NPTEL : Introduction to Biomaterials (Metallurgy and Material Science)**

**Co-ordinators : Dr. Kantesh Balani, Dr. Birkamjit Basu**

Lecture 1 - Introduction to basic concepts of Biomaterials Science; Salient properties of important material classes; overview of body environment,

Lecture 2 - Manufacturing and properties of metals, ceramics, polymers and composites

Lecture 3 - Concept of biocompatibility, host response, structure-property of biological cell

Lecture 4 - Structure and properties of cells, protein and cellular adaptation process

Lecture 5 - Cell-I

Lecture 6 - Cell-II

Lecture 7 - Cell Migration and Cell Division and cell death

Lecture 8 - Cell Differentiation and Cell Death

Lecture 9 - Cell Apoptosis-I

Lecture 10 - Cell Apoptosis-II

Lecture 11 - Structure and properties of Protein; cell - material interaction

Lecture 12 - Assessment of biocompatibility of biomaterials

Lecture 13 - Biological testing (hemocompatibility, tribological testing)

Lecture 14 - Structure and properties of bone as well as in vivo testing and histocompatibility assessment

Lecture 15 - Important biometallic alloys

Lecture 16 - Ti Alloy

Lecture 17 - Co-Cr-Mo alloys

Lecture 18 - Bioceramics

Lecture 19 - Processing of Bioceramics

Lecture 20 - Ceramics, Bioceramics and Glasses

Lecture 21 - Sintering and mechanical properties of ceramics

Lecture 22 - Fracture and toughening of ceramic composites

Lecture 23 - Development of based bioceramic composites for hard tissue replacement

Lecture 24 - Alternative phosphate materials, based composites with bactericidal property and glass ceramics for dental restoration

Lecture 25 - Electrostatic Spraying of UHMWPE-HA-CNT composites

Lecture 26 - Thin Films and Coatings

Lecture 27 - Thermal Spray Coatings

Lecture 28 - Biocompatibility of plasma sprayed CNT reinforced Hydroxyapatite biocomposite coatings

Lecture 29 - Biocompatibility of Alumina and CNT reinforced Hydroxyapatite

Lecture 30 - Glass-ceramics for dental restoration applications

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[Lecture 31 - Structure and properties of polymers](#)

[Lecture 32 - Biodegradable polymers \(Importance\)](#)

[Lecture 33 - Biodegradable polymers \(Types\)](#)

[Lecture 34 - Mechanisms of Bioerosion](#)

[Lecture 35 - External field and material interaction](#)

[Lecture 36 - Tissue Engineering and wound healing](#)

[Lecture 37 - Understanding Design Concepts of Bio-implants](#)

[Lecture 38 - Understanding Design Concepts of Dental-implants](#)

[Lecture 39 - Understanding Design Concepts of Orthopedic-implant](#)

Lecture 1 - Introduction to Course

Lecture 2 - Measurement of Quantities

Lecture 3 - Exercises on Measurement of Quantities, Introduction to Stoichiometry

Lecture 4 - Stoichiometry Concept and Exercise

Lecture 5 - Exercise on Stoichiometry and Introduction to Thermochemistry

Lecture 6 - Thermochemistry

Lecture 7 - Exercise on Thermochemistry & Frequently Asked Questions

Lecture 8 - Errors in Measurements

Lecture 9 - Basics of Materials & Energy Balance

Lecture 10 - Introduction to Mineral Beneficiation

Lecture 11 - Materials Balance in Mineral Processing and Faq

Lecture 12 - Exercises in Mineral Processing

Lecture 13 - Calcination Concepts & Exercises

Lecture 14 - Pyromet Extraction Unit Processes

Lecture 15 - Predominance Area Diagram

Lecture 16 - Material Balance in Roasting; illustration

Lecture 17 - Heat Balance in Roasting illustration

Lecture 18 - Exercises on Roasting

Lecture 19 - Exercises on Roasting

Lecture 20 - Smelting Matte Smelting

Lecture 21 - Exercise-I Matte Smelting

Lecture 22 - Exercise-II Matte Smelting

Lecture 23 - Reduction Smelting

Lecture 24 - Lead Smelting Material Balance

Lecture 25 - Imperial Smelting Process

Lecture 26 - Introduction to Ironmaking

Lecture 27 - Coke Making

Lecture 28 - Ironmaking Fundamentals

Lecture 29 - Material & Heat Balance in Ironmaking - I

Lecture 30 - Material & Heat Balance in Ironmaking - II

Lecture 31 - RIST Diagram - I

[Lecture 32 - RIST Diagram - II](#)

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[Lecture 34 - Exercise in Converting](#)

[Lecture 35 - Additional Topics - I Melting in Cupola](#)

[Lecture 36 - Additional Topics - II Gasification](#)

[Lecture 37 - Additional Topics - III Material Balance in Gasification](#)

[Lecture 38 - Additional Topics - IV Industrial Furnaces](#)

[Lecture 39 - Energy Balance in Industrial Furnaces](#)

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Lecture 1 - Conductivity of materials, Drude's theory and its failures

Lecture 2 - Free electron theory

Lecture 3 - Free electron theory

Lecture 4 - Crystal structure, Reciprocal lattice I

Lecture 5 - Reciprocal lattice II, Brillouin zone and Bragg's diffraction condition

Lecture 6 - Electrons in a crystal, Bloch's electron

Lecture 7 - Free electron band diagrams in an empty lattice

Lecture 8 - Effect of periodic potential, Origin of band-gap through Kronig-Penny model

Lecture 9 - Electron dynamics

Lecture 10 - Conduction in relation to band diagrams

Lecture 11 - Semiconductor E-k diagrams and their material properties

Lecture 12 - Equilibrium carrier statistics in semiconductors: density of states, fermi function and population density in bands

Lecture 13 - Equilibrium carrier statistics in semiconductors: qualitative examination of carrier densities in conduction and valence bands

Lecture 14 - Equilibrium carrier statistics in semiconductors: quantitative examination of carrier densities in intrinsic semiconductor

Lecture 15 - Doping in semiconductors

Lecture 16 - Equilibrium carrier statistics in semiconductors: complete ionization of dopant levels

Lecture 17 - Equilibrium carrier statistics in semiconductors: carrier freeze out

Lecture 18 - Semiconductor junctions in band-diagrams

Lecture 19 - Linear dielectric behavior

Lecture 20 - Non-linear dielectric behavior

Lecture 21 - Carrier recombination-generation - I: band-to-band transition

Lecture 22 - Carrier recombination-generation - II: Other mechanisms

Lecture 23 - R-G statistics via R-G centers

Lecture 24 - Optoelectronic materials and bandgap engineering

Lecture 25 - Optical properties of materials

Lecture 26 - Optical properties of single interfaces: Fresnel reflection coefficients

Lecture 27 - Optical Properties of two interfaces: thin film case

Lecture 28 - Drift

Lecture 29 - Diffusion

Lecture 30 - Continuity Equation

Lecture 31 - Resistor and diode (p-n junction)



[Lecture 32 - Fundamentals of p-n junction](#)

[Lecture 33 - Fundamentals of p-n junction \(Continued...\)](#)

[Lecture 34 - Solar cells](#)

[Lecture 35 - Microelectronics processing](#)

[Lecture 36 - MOS capacitor](#)

[Lecture 37 - Transistor](#)

[Lecture 38 - Organic Electronics](#)

[Lecture 39 - Organic Light Emitting Diodes](#)

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**NPTEL : Steel Making (Metallurgy and Material Science)**

**Co-ordinators : Prof. Satish Ch. Koria, Prof. Dipak Mazumdar**

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Lecture 1 - Introduction, Basic definition of corrosion

Lecture 2 - Forms of Degradation, Thermodynamics of corrosion

Lecture 3 - Thermodynamics of corrosion

Lecture 4 - Thermodynamics of corrosion

Lecture 5 - Thermodynamics of corrosion, Electrochemical series, Concentration cell

Lecture 6 - Reduction Potential series, Pourbaix diagram

Lecture 7 - Pourbaix diagram

Lecture 8 - Pourbaix diagram

Lecture 9 - Pourbaix diagram, Kinetics of corrosion

Lecture 10 - Kinetics of corrosion, Rate expression, Solved problems

Lecture 11 - Solved problems on the corrosion rate, Exchange current density

Lecture 12 - Exchange current density, Polarization, Activation Polarization, Tafel Equation

Lecture 13 - Activation Polarization, Concentration Polarization

Lecture 14 - Concentration Polarization, Mixed Potential Theory

Lecture 15 - Mixed Potential Theory, Explanation of corrosion events on the basis of Mixed potential theory, Galvanization

Lecture 16 - Explanation of corrosion events on the basis of Mixed potential theory, Effect of impurity, Effect of area factor

Lecture 17 - Explanation of corrosion events on the basis of Mixed potential theory, Effect of area factor, Concentration polarization, Passivation

Lecture 18 - Passivation and Mixed potential theory

Lecture 19 - Passivation and Mixed potential theory

Lecture 20 - Different corrosion protection mechanisms, electrochemical ways of protection, cathodic protection

Lecture 21 - Cathodic and anodic protection

Lecture 22 - Anodic protection, Forms of corrosion, Factors of corrosion

Lecture 23 - Forms of corrosion, Uniform Corrosion, Galvanic corrosion

Lecture 24 - Galvanic corrosion

Lecture 25 - Crevice corrosion

Lecture 26 - Crevice corrosion, Pitting corrosion

Lecture 27 - Pitting corrosion, Intergranular corrosion

Lecture 28 - Intergranular corrosion, Dealloying

Lecture 29 - Dealloying, Erosion corrosion

Lecture 30 - Erosion corrosion, Cavitation

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Lecture 31 - Cavitation, Fretting corrosion, corrosion cracking

Lecture 32 - Stress corrosion cracking: mechanisms (dissolution controlled)

Lecture 33 - Stress corrosion cracking: mechanisms (cleavage controlled), factors affecting SCC, hydrogen embrittlement, corrosion fatigue

Lecture 34 - Biologically influenced corrosion, liquid metal attack

Lecture 35 - Corrosion protection, change of materials, effect of design of component

Lecture 36 - Corrosion protection, change of environment, Inhibitors, coatings

Lecture 37 - Oxidation and hot corrosion, pitting Bedworth ratio, thermodynamics of oxidation

Lecture 38 - Thermodynamics of oxidation, Ellingham diagram, oxidation kinetics and laws

Lecture 39 - Oxide structure and Oxidation

Lecture 40 - Hot corrosion, corrosion testing and failure analysis, linear polarization

Lecture 41 - Degradation of composites, polymers and ceramics, corrosion and society

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Lecture 2 - Heterogeneous equilibrium and Free energy Formalism

Lecture 3 - Concept of Chemical Potential

Lecture 4 - Phase Rule-I

Lecture 5 - Phase Rule-II and Single Component Equilibria

Lecture 6 - Single Component Phase Diagram

Lecture 7 - Binary Phase Diagram - Isomorphous Diagram

Lecture 8 - Binary Isomorphous System

Lecture 9 - Solidification of Isomorphous Alloys

Lecture 10 - Free Energy of Binary Isomorphous Phase Diagram

Lecture 11 - Phase Diagram of Binary Eutectic Systems Edit Lesson

Lecture 12 - Solidification of eutectic, hypo-eutectic and hyper-eutectic alloys & their morphologies - I

Lecture 13 - Solidification of eutectic, hypo-eutectic and hyper-eutectic alloys & their morphologies - II

Lecture 14 - Phase diagrams of binary eutectic two terminal solid solution

Lecture 15 - Phase diagrams of binary peritectic System - I

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Lecture 19 - Introduction to Monotectic Phase Diagram

Lecture 20 - Microstructural Evolution of Monotectic Phase Diagram

Lecture 21 - Free Energy Composition diagrams for Monotectic systems and Syntactic phase diagram

Lecture 22 - Quasichemical theory - I

Lecture 23 - Quasichemical theory - II

Lecture 24 - Quasichemical theory Free energy formalism

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Lecture 26 - Introduction to Iron-Carbon phase diagram

Lecture 27 - Eutectoid transformation in Iron-Carbon phase diagram

Lecture 28 - Austenite to pearlite transformation in Iron-Carbon phase diagram

Lecture 29 - Hypo-eutectoid steels

Lecture 30 - Pearlite Transformation

Lecture 31 - Martensite Transformation - I



- Lecture 32 - Martensite Transformation - II
- Lecture 33 - Tempering of Martensite
- Lecture 34 - Bainite Transformation
- Lecture 35 - TTT curves for Steel
- Lecture 36 - Cast Iron - I
- Lecture 37 - Cast Iron - II
- Lecture 38 - Ductile Iron and Nodular Iron
- Lecture 39 - Malleable Iron
- Lecture 40 - Alloyed Cast Iron
- Lecture 41 - Phase Diagram for different Solid State Reaction
- Lecture 42 - Phase Diagram of Ceramic
- Lecture 43 - Ternary Phase Diagram - I
- Lecture 44 - Ternary Phase Diagram - II
- Lecture 45 - Ternary Phase Diagram and Tie Line Construction - I
- Lecture 46 - Ternary Phase Diagram and Tie Line Construction - II
- Lecture 47 - Ternary Phase Diagram and Tie Line Construction - III
- Lecture 48 - Ternary Isomorphous Phase Diagram
- Lecture 49 - Ternary Three Phase Equilibria
- Lecture 50 - Three Phase Equilibria in Ternary Systems - I
- Lecture 51 - Three Phase Equilibria in Ternary Systems - II
- Lecture 52 - Solidification Behaviour of Ternary Alloy
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- Lecture 54 - Ternary Four Phase Equilibria - I
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- Lecture 56 - Solidification Behaviour of Ternary Eutectic Alloys
- Lecture 57 - Phase Diagram of Ternary Eutectic with Terminal Solid Solution
- Lecture 58 - Ternary Peritectic Reaction
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- Lecture 60 - Case Studies on Ternary Phase Diagrams - I
- Lecture 61 - Case Studies on Ternary Phase Diagrams - II

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Lecture 2 - Solidification (Casting)

Lecture 3 - Solidification (Welding)

Lecture 4 - Thermodynamics of Solidification

Lecture 5 - Kinetics of Solidification (Homogeneous)

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Lecture 8 - Heat Flow (Continued...)

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Lecture 10 - Heat Flow (Insulating Mold Condition) (Continued...)

Lecture 11 - Heat Flow (Interface Resistance Controlled Solidification)

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Lecture 19 - Zone Refining (Continued...)

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Lecture 22 - Cellular Solidification of Single Phase Alloy (Continued...)

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Lecture 28 - Powder characterization

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[Lecture 40 - Sintering Theory](#)

- Lecture 1 - Introduction to Heat Treatment and Importance of Material Tetrahedron
- Lecture 2 - Case studies in reference to Material tetrahedron T/t information and processing
- Lecture 3 - Few more case studies in reference to processing with T/t modification
- Lecture 4 - Critical Definition and Phase Transformation Thermodynamics and Driving Force
- Lecture 5 - Thermodynamics of Phase Transformation Driving force of Phase Transformation
- Lecture 6 - Thermodynamics of Phase Transformation and Driving Force for Phase Transformation
- Lecture 7 - Finding Value of Driving Force ( $\Delta G$ ) and Single Component (liquid-solid)
- Lecture 8 - Finding Value of Driving Force ( $\Delta G$ ) and Nucleation Single Component (liquid-solid)
- Lecture 9 - Nucleation Treatment Single Component (Solid-Liquid) - I
- Lecture 10 - Nucleation Treatment Single Component (Solid-Liquid) - II
- Lecture 11 - Solved Problem on Nucleation rate and How to determine the value of  $\Delta \sigma_{sl}$  Physical Concept & Interfacial Energy
- Lecture 12 - How to determine the value of  $\Delta \sigma_{sl}$  (Physical Concept and Interfacial Energy)
- Lecture 13 - Interfacial Energy - I
- Lecture 14 - Interfacial Energy - II
- Lecture 15 - Heterogeneous Nucleation - I
- Lecture 16 - Heterogeneous Nucleation - II
- Lecture 17 - Solid - Solid Transformation and Nucleation rate - I
- Lecture 18 - Solid - Solid Transformation and Nucleation rate - II
- Lecture 19 - Phase Diagram and G vs X plot - I
- Lecture 20 - Phase Diagram and G vs X plot - II
- Lecture 21 - Phase Diagram and G vs X plot - III
- Lecture 22 - Introduction to Kinetics of Phase Transformation
- Lecture 23 - Variation of  $\Delta G^*$  and  $r^*$  with Undercooling
- Lecture 24 - Nucleation rate - I
- Lecture 25 - Nucleation Rate - II
- Lecture 26 - Critical Undercooling
- Lecture 27 - Maximum nucleation rate for homogeneous nucleation
- Lecture 28 - Maximum nucleation rate for heterogeneous nucleation
- Lecture 29 - Nucleation kinetics in solid state
- Lecture 30 - Interface controlled growth
- Lecture 31 - Diffusion controlled growth

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Lecture 2 - Continuum Mechanics

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Lecture 4 - Strain Tensors and Mohr circle for strains

Lecture 5 - Yield Stress Criterion

Lecture 6 - Effective Stress and Strain

Lecture 7 - Work Hardening and Flow Behaviour

Lecture 8 - Effect of Strain Rate

Lecture 9 - Combined Effect of Strain, Strain Rate and Temperature

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Lecture 12 - Mechanics of Metal Working

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Lecture 14 - Wire Drawing (Continued...)

Lecture 15 - Hodographs

Lecture 16 - Upper-Bound Analysis

Lecture 17 - Plane Strain Indentation

Lecture 18 - Strain Calculation Models and Friction

Lecture 19 - Types of Friction

Lecture 20 - Effect of Friction in Rolling

Lecture 21 - Vacuum Technology

Lecture 22 - Vacuum Technology (Continued...)

Lecture 23 - Thermal Evaporation

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Lecture 3 - Correlation between bond and physical properties

Lecture 4 - Crystal Structure: Lattice and Basis

Lecture 5 - Unit Cell (Primitive and Non-primitive)

Lecture 6 - Crystal Systems and Bravais Lattices

Lecture 7 - Bravais Lattice and Symmetry in Crystals

Lecture 8 - Symmetry in Crystals

Lecture 9 - Symmetry and Correlation with the Bravais Lattice

Lecture 10 - Miller Indices (Planes and Directions)

Lecture 11 - Miller Indices - Part 2

Lecture 12 - Miller Indices - Part 3

Lecture 13 - Miller Indices and Weiss Zone Law

Lecture 14 - Structure of Metals and Alloys

Lecture 15 - Structure of Metals, Packing, Co-ordination and Interstices

Lecture 16 - Interstices, Solid Solutions and Alloys

Lecture 17 - Solid Solutions: Alloys

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Lecture 20 - Covalent Solids (Continued...) and Ionic Solids

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Lecture 4 - Vacancy Concentration Measurement Techniques

Lecture 5 - Self-interstitial Defects+Frenkel Defects

Lecture 6 - Schottky Defects+Extrinsic Defects

Lecture 7 - Interstitials in Iron

Lecture 8 - Defects Reaction+Kroger-Vink Notation

Lecture 9 - Defects Reaction and its Thermodynamics

Lecture 10 - Equilibrium Concentration using Defects Reaction

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Lecture 12 - Diffusion (Interstitial Diffusion)

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Lecture 14 - Self-diffusion + Examples

Lecture 15 - Diffusion in substitutional alloys+Diffusion along defects

Lecture 16 - History of Dislocations

Lecture 17 - Volterra Model + Structure of Dislocations + Burger vectors

Lecture 18 - Characteristics of Dislocations

Lecture 19 - Mixed Dislocations + Dislocation Loops

Lecture 20 - Elastic Continuum Model + Strain field for screw dislocations

Lecture 21 - Stress and Strain Fields

Lecture 22 - Stress State around Edge Dislocations+Elastic Energy of Dislocations

Lecture 23 - Glide Forces on Dislocations+Line Tension on Dislocations

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Lecture 29 - Critical resolved Shear Stress+Examples (Continued...)

Lecture 30 - Glide+Kinks

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[Lecture 36 - Observation of dislocation \(Continued...\) + Dislocation Dynamics](#)

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Lecture 26 - Solar Cell Device Parameters

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Lecture 16 - Interaction of point defects and dislocation - Solid Solution Strengthening

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Lecture 12 - Composites, Anelastic Behaviour

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- Lecture 4 - Equilibrium, Stability and Phase Diagrams in Single Component Systems
- Lecture 5 - Third Law of Thermodynamics and Numerical Examples
- Lecture 6 - Thermodynamic Activity and Gibbs Free Energy of Mixing
- Lecture 7 - Entropy of mixing of Multicomponent Ideal Solution
- Lecture 8 - Regular Solution Model: Application to Ternary System
- Lecture 9 - Gibbs Free Energy-Composition Curves, Phase Diagrams and Gibbs Phase rule
- Lecture 10 - Exercise: Solution Thermodynamics
- Lecture 11 - Driving force for Diffusion, Chemical Potentials and Concentrations
- Lecture 12 - Diffusion flux and Frames of Reference
- Lecture 13 - Fick's Law
- Lecture 14 - Exercise: Deriving Sigma Cosine for any Cubic Lattice
- Lecture 15 - Fick's Law for Multicomponent Diffusion
- Lecture 16 - Diffusion Equation and Solution to Steady State Diffusion
- Lecture 17 - Conversion of Set of Interdiffusion Coefficients from One Dependent Compared to Another
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- Lecture 22 - Solution to Diffusion Equation for Binary Diffusion Couple
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- [Lecture 50 - Soft and Hard Magnetic Materials \(Continued...\)](#)
- [Lecture 51 - Advanced Processes](#)
- [Lecture 52 - Advanced Processes \(Continued...\)](#)
- [Lecture 53 - Advanced Processes \(Continued...\)](#)
- [Lecture 54 - Advanced Processes \(Continued...\)](#)
- [Lecture 55 - Advanced Processes \(Continued...\)](#)
- [Lecture 56 - Advanced Functional Alloys](#)
- [Lecture 57 - Advanced Functional Alloys \(Continued...\)](#)
- [Lecture 58 - Advanced Functional Alloys \(Continued...\)](#)
- [Lecture 59 - Advanced Functional Alloys \(Continued...\)](#)
- [Lecture 60 - Advanced Functional Alloys \(Continued...\)](#)



Lecture 1 - Structure of Solids

Lecture 2 - Microstructure of Solids

Lecture 3 - Defects in Crystalline Solids

Lecture 4 - Surface and Surface Energy

Lecture 5 - Surface Properties-due to mechanical activation

Lecture 6 - Surface dependent physical and chemical property

Lecture 7 - Surface Dependent Properties and Surface initiated Degradation

Lecture 8 - Fatigue

Lecture 9 - Wear Part - I

Lecture 10 - Wear Part - II

Lecture 11 - Wear Part - III

Lecture 12 - Corrosion - I

Lecture 13 - Corrosion - II

Lecture 14 - Corrosion - III

Lecture 15 - Corrosion - IV

Lecture 16 - Corrosion - V

Lecture 17 - Classification of Surface engineering

Lecture 18 - Strengthening of metals

Lecture 19 - Strengthening of Non-Metals

Lecture 20 - Diffusive transformation in Steel

Lecture 21 - Non-Diffusive transformation in Steel

Lecture 22 - Shot Peening

Lecture 23 - Shot Peening and Rolling

Lecture 24 - Flame Hardening and Induction Hardening

Lecture 25 - Case Carburizing

Lecture 26 - Liquid Carburizing and Gas Carburizing

Lecture 27 - Gas Nitriding

Lecture 28 - Liquid and Salt Bath Nitriding

Lecture 29 - Plasma Nitriding and Ion Implantation

Lecture 30 - Heat treatment after carburizing and Nitriding

Lecture 31 - Diffusion Coating Principle

[Lecture 32 - Diffusion Coating Processes](#)

[Lecture 33 - Thick Coating by Cladding](#)

[Lecture 34 - High Temperature Degradation](#)

[Lecture 35 - Corrosion Prevention](#)

[Lecture 36 - Chemical Conversion Coating](#)

[Lecture 37 - Electroconversion Coating](#)

[Lecture 38 - Electro and Electroless Deposition Process](#)

[Lecture 39 - Hot Dipping - I](#)

[Lecture 40 - Hot Dipping - II](#)

[Lecture 41 - Thermal Spray Deposition - I](#)

[Lecture 42 - Thermal Spray Deposition - II](#)

[Lecture 43 - Thermal Spray Deposition - III](#)

[Lecture 44 - Thermal Spray Deposition - IV](#)

[Lecture 45 - Physical Vapor Deposition \(PVD\)](#)

[Lecture 46 - Sputtering](#)

[Lecture 47 - Chemical Vapor Deposition \(CVD\)](#)

[Lecture 48 - Composite Coating](#)

[Lecture 49 - Ion Implantation - I](#)

[Lecture 50 - Ion Implantation - II](#)

[Lecture 51 - Electron Beam Welding](#)

[Lecture 52 - Electron Beam Surface engineering](#)

[Lecture 53 - Laser Materials Processing: Introduction](#)

[Lecture 54 - Laser Assisted Materials Processing:Processes](#)

[Lecture 55 - Laser Surface Engineering:Hardening and Melting](#)

[Lecture 56 - Laser Surface Engineering with Laser surface hardening and laser surface melting](#)

[Lecture 57 - Laser Surface Alloying](#)

[Lecture 58 - Laser Surface Cladding](#)

[Lecture 59 - Surface Damage - Case Studies](#)

[Lecture 60 - Overview and Conclusion](#)

Lecture 1 - Introduction

Lecture 2 - Various Routes of steelmaking

Lecture 3 - The Iron Blast Furnace

Lecture 4 - Thermodynamics of BF ironmaking

Lecture 5 - Thermodynamics of BF Ironmaking (Continued...)

Lecture 6 - Overall Heat and Material Balance in Blast Furnace

Lecture 7 - RIST Diagram based on overall heat and material balance

Lecture 8 - RIST Diagram based on heat and material balance in the Wustite Reserve Zone

Lecture 9 - Kinetics of gas solid reaction: Iron oxide reduction - Part 1

Lecture 10 - Kinetics of gas solid reaction: Iron oxide reduction - Part 2

Lecture 11 - Aerodynamics in Blast Furnace - Part 1

Lecture 12 - Aerodynamics in Blast Furnace - Part 2: Channeling

Lecture 13 - Aerodynamics in Blast Furnace - Part 3: Flooding

Lecture 14 - Coke rate and Fuel efficiency in Blast Furnace

Lecture 15 - oxygen enrichment of blast

Lecture 16 - Blast Furnace and it's Raw Material

Lecture 17 - Sintering of Iron Ore

Lecture 18 - Pelletization of Iron Ore

Lecture 19 - Coking Process

Lecture 20 - Testing of Burden Material

Lecture 21 - Burden Distribution

Lecture 22 - Blast Furnace products and their utilization

Lecture 23 - Blast Furnace Productivity

Lecture 24 - Modeling of Blast Furnace

Lecture 25 - New Potential Technologies for Blast Furnace

Lecture 26 - History of Steelmaking

Lecture 27 - Properties of slag

Lecture 28 - The Reaction Equilibria Unlisted

Lecture 29 - Dephosphorization of liquid steel

Lecture 30 - Kinetics of slag metal reaction

Lecture 31 - LD steelmaking: Basics, process steps, emulsion formation and stabilization

- Lecture 32 - LD Steel making: Oxygen lance and jet action and decarburization
- Lecture 33 - Evolution of impurities in steel and slag constituents during LD processing
- Lecture 34 - Hybrid Processes
- Lecture 35 - Electric steel making
- Lecture 36 - Secondary Steel making: Introduction and de-oxidation
- Lecture 37 - Secondary Steel making: Introduction and de-oxidation (Continued...)
- Lecture 38 - Secondary Steel making: Vacuum Techniques for refining steel
- Lecture 39 - Homogenization and Gas stirred ladle
- Lecture 40 - Ladle de-sulphurization, alloying, stainless steel making
- Lecture 41 - Inclusion and its control
- Lecture 42 - Injection Metallurgy: Submerged injection of calcium powder
- Lecture 43 - Cored wire injection-Modeling, melting sequence, effect of operating parameters
- Lecture 44 - IM: Cored wire injection: Industrial implications
- Lecture 45 - IM: Tundish metallurgy and design
- Lecture 46 - Casting fundamentals- Heat Transfer
- Lecture 47 - Casting fundamentals- segregation
- Lecture 48 - Morphology of solidification structure and Ingot casting
- Lecture 49 - Continuous casting
- Lecture 50 - Downstream processing and near net shape casting
- Lecture 51 - Introduction to Direct Reduction (DR) and smelting Reduction (SR) Processes
- Lecture 52 - Introduction to Direct Reduction (DR) and smelting Reduction (SR) Processes (Continued...)
- Lecture 53 - Coal Based DR Processes
- Lecture 54 - Coal Based DR Processes (Continued...)
- Lecture 55 - Gas based DR Processes
- Lecture 56 - Gas based DR Processes (Continued...)
- Lecture 57 - Smelting Reduction (SR) Processes
- Lecture 58 - Smelting Reduction (SR) Processes (Continued...)
- Lecture 59 - Ironmaking and Steelmaking in India
- Lecture 60 - Ironmaking and Steelmaking in India (Continued...)

Lecture 1 - Classification and applications of non-metallic materials

Lecture 2 - Understanding on polymer structures

Lecture 3 - Characteristics of polymers and advanced polymeric materials

Lecture 4 - Processing of polymers

Lecture 5 - Polymer composites and issues related to recycling

Lecture 6 - Defects in crystalline materials: point, line, planar and three dimensional defects

Lecture 7 - Non- stoichiometry in non-metallic materials

Lecture 8 - Laws of thermodynamics, reaction kinetics - Part 1

Lecture 9 - Laws of thermodynamics, reaction kinetics - Part 2

Lecture 10 - Phase diagram and microstructure evolution in non-metallic materials

Lecture 11 - Carbonaceous materials

Lecture 12 - Fundamental of diffusion, Fick's laws, their solution and applications - Part 1

Lecture 13 - Fundamental of diffusion, Fick's laws, their solution and applications - Part 2

Lecture 14 - Phase transformation of non-metallic materials

Lecture 15 - Introduction to glass and amorphous solids

Lecture 16 - Understanding on conventional glass and amorphous solids

Lecture 17 - Glass-ceramics and specialty glasses

Lecture 18 - Mechanical properties of non-metallic materials, stress-strain response, elastic, and plastic deformation

Lecture 19 - Brittle and ductile materials, introduction to fracture mechanics, strength of brittle materials

Lecture 20 - Strengthening of materials, fatigue, and creep

Lecture 21 - Composite materials: Particle-reinforced composites, and fiber reinforced composites

Lecture 22 - Structural Composite

Lecture 23 - Dielectric and piezoelectric behavior

Lecture 24 - Ferroelectric Behaviour of Non-Metallic Materials and Ferroelectric thin film for Non-Volatile Memory Applications

Lecture 25 - Magnetic Properties : Origin of Magnetism, Para, Dia, Ferro, and Ferrimagnetism

Lecture 26 - Ceramic Magnets and their Applications

Lecture 27 - Thermal Properties : Specific Heat, Heat Conduction, Thermal Diffusivity, Thermal expansion

Lecture 28 - Thermoelectric Effect and Magnetocaloric Effect

Lecture 29 - Optical properties: Refractive index, absorption and transmission of electromagnetic radiation, LASERS

Lecture 30 - Introduction to electrochemistry, Galvanic cells, Cell potentials and Gibbs Energy, Concentration dependence

Lecture 31 - Electrochemical storage, rechargeable batteries

Lecture 32 - Introduction to electrochemical methods; cyclic voltammetry and other related techniques

Lecture 33 - Fuel Cell and Energy harvesting

Lecture 34 - Preparation of ceramic powders: auto-combustion, sol-gel synthesis, microwave assisted hydrothermal synthesis

Lecture 35 - Introduction to sintering, sintering mechanism

Lecture 36 - Solid-state sintering and microstructure development

Lecture 37 - Solid-state sintering and microstructure development (Continued...)

Lecture 38 - Liquid phase sintering and microstructure development, speciality sintering, reactive sintering

Lecture 39 - Processing of glass and amorphous/non-crystalline solids

Lecture 40 - Fundamental of thin film growth, growth mechanism and kinetics

Lecture 41 - Thin film growth techniques, thermal evaporation, CVD, sputtering, CSD

Lecture 42 - Fundamentals and processing of conducting and semiconducting ceramic devices

Lecture 43 - Processing of ceramics devices

Lecture 44 - Organic electronic materials: conducting polymers, semi-conducting organic materials, applications

Lecture 45 - Thermal analyses

Lecture 46 - Introduction of spectroscopic technique : UV-VIS spectroscopy

Lecture 47 - Infra-red and Raman spectroscopy

Lecture 48 - Optical and scanning electron microscopy

Lecture 49 - X-ray photoelectron spectroscopy

Lecture 50 - Measurement of mechanical properties, fracture toughness, MOR, hardness

Lecture 51 - Ferroelectric thin film: synthesis and characterization

Lecture 52 - Thermal analysis techniques: Differential scanning calorimetry and thermogravimetry

Lecture 53 - Measurement of optical properties

Lecture 54 - Novel ferroic composites: Synthesis and measurement

Lecture 55 - Fundamentals of corrosion, corrosion of materials

Lecture 56 - Oxidation, corrosion of ceramic materials, degradation of polymers: swelling and dissolution, bond rupture, weathering

Lecture 57 - Ceramics in biology and medicine

Lecture 58 - Design of Ceramics

Lecture 59 - Finishing of Ceramics

Lecture 60 - Fly-ash based glazed wall tiles: A case study

Lecture 1 - Introduction to Microscopy

Lecture 2 - Scanning Electron Microscopy

Lecture 3 - SEM and Its Capabilities

Lecture 4 - Main Components of SEM - Electron Guns

Lecture 5 - Main Components of SEM - Electron Guns and Electromagnetic Lenses

Lecture 6 - Electron Probe Diameter Verses Electron Probe Current

Lecture 7 - Electron Beam - Specimen Interaction

Lecture 8 - Detectors

Lecture 9 - BSE Detector and Sample Preparation for SEM

Lecture 10 - Parameters Need to be Considered to obtain a Good SEM Image

Lecture 11 - How to Get a Good SEM Image

Lecture 12 - Additional Capabilities of SEM

Lecture 13 - Additional Capabilities of SEM (Continued...)

Lecture 14 - Additional Capabilities of SEM (Continued...)

Lecture 15 - Scanning Ion Microscopy - An Introduction

Lecture 16 - Ions Versus Electrons as Source for Microscopy

Lecture 17 - Ions Source in HIM

Lecture 18 - GFIS Properties and Ion Optical Column

Lecture 19 - Ion Optical Column

Lecture 20 - Ion-Solid Interactions and Signal Generation

Lecture 21 - Signal Generation and Contrast Mechanism

Lecture 22 - Contrast Mechanism and Imaging Modes

Lecture 23 - Scanning Transmission Ion Microscopy and Microanalysis with HIM

Lecture 24 - Creation and Modification of Materials by HIM

Lecture 25 - Introduction to Scanning Probe Microscopy

Lecture 26 - STM Instrumentation

Lecture 27 - Main Components of STM

Lecture 28 - Main Components of STM (Continued...)

Lecture 29 - Main Components of STM (Continued...)

Lecture 30 - Working Principle of STM

Lecture 31 - Operating Modes

[Lecture 32 - Scanning Tunneling Spectroscopy](#)

[Lecture 33 - SPM - Atomic Force Microscopy \(AFM\)](#)

[Lecture 34 - Force Between Tip and Sample in AFM](#)

[Lecture 35 - Atomic Force Microscope - Parts](#)

[Lecture 36 - Modes of AFM Operation](#)

[Lecture 37 - Modes of AFM Operation \(Continued...\)](#)

[Lecture 38 - AFM Imaging](#)

[Lecture 39 - Phase Imaging, Noises and Resolution](#)

[Lecture 40 - Surface Properties Measurements using Other Forces](#)

[Lecture 41 - Surface Properties Measurements using AFM](#)

[Lecture 42 - Manipulation of Atoms, Molecules and Industrial Applications](#)

[Lecture 43 - Summary](#)



Lecture 1 - Introduction to the course and basic principles of image formation

Lecture 2 - Image formation, resolution, magnification, depth of field and depth of focus

Lecture 3 - Aberrations in microscopy: General concepts

Lecture 4 - Introduction, types and image formation in Optical microscopy

Lecture 5 - Components of optical microscope

Lecture 6 - Bright field and Dark field modes

Lecture 7 - Phase contrast optical microscopy

Lecture 8 - Polarized light microscopy

Lecture 9 - Differential interference contrast

Lecture 10 - Fluorescence microscopy

Lecture 11 - Basic components of electron microscope

Lecture 12 - Basic components of electron microscope (Continued...)

Lecture 13 - Basic components of electron microscope (Continued...)

Lecture 14 - Electron-material interaction

Lecture 15 - Electron-material interaction (Continued...)

Lecture 16 - Electron-material interaction (Continued...) and Image formation and contrast generation

Lecture 17 - Modes of TEM (BF and DF)

Lecture 18 - Modes of TEM

Lecture 19 - Modes of TEM (Continued...) and Electron diffraction in TEM

Lecture 20 - Electron diffraction in TEM

Lecture 21 - Electron diffraction in TEM (Continued...)

Lecture 22 - Electron diffraction in TEM (Continued...)

Lecture 23 - Electron diffraction in TEM (Continued...)

Lecture 24 - Electron diffraction in TEM (Continued...)

Lecture 25 - Application of Electron diffraction

Lecture 26 - Signal generation in SEM

Lecture 27 - Signal generation in SEM (Continued...)

Lecture 28 - Signal generation in SEM (Continued...)

Lecture 29 - Signal generation in SEM (Continued...)

Lecture 30 - Signal generation in SEM (Continued...)

Lecture 31 - Basic components of SEM

- [Lecture 32 - Basic components of SEM \(Continued...\)](#)
- [Lecture 33 - Optics of SEM](#)
- [Lecture 34 - Optics of SEM \(Continued...\)](#)
- [Lecture 35 - Optics of SEM \(Continued...\) and analytical detectors](#)
- [Lecture 36 - Analytical detectors in SEM](#)
- [Lecture 37 - Analytical \(WDS\) detector and contrast formation in SEM](#)
- [Lecture 38 - Imaging in SEM](#)
- [Lecture 39 - Imaging in SEM \(Continued...\)](#)
- [Lecture 40 - Imaging in SEM \(Continued...\)](#)
- [Lecture 41 - Imaging in SEM and X-ray diffraction](#)
- [Lecture 42 - Continuous and characteristics X-ray spectrum](#)
- [Lecture 43 - Characteristics X-ray radiation](#)
- [Lecture 44 - Characteristics X-ray radiation \(Continued...\) and X-ray absorption](#)
- [Lecture 45 - X-ray absorption \(Continued...\)](#)
- [Lecture 46 - X-ray absorption and filters](#)
- [Lecture 47 - Intensity of diffracted beam](#)
- [Lecture 48 - Intensity of diffracted beam \(Continued...\)](#)
- [Lecture 49 - Intensity of diffracted beam \(Continued...\)](#)
- [Lecture 50 - Intensity of diffracted beam \(Continued...\)](#)
- [Lecture 51 - Intensity of diffracted beam \(Continued...\)](#)
- [Lecture 52 - Intensity of diffracted beam \(Continued...\)](#)
- [Lecture 53 - Intensity of diffracted beam \(Continued...\)](#)
- [Lecture 54 - Intensity of diffracted beam \(Continued...\)](#)
- [Lecture 55 - Intensity of diffracted beam \(Continued...\)](#)
- [Lecture 56 - Intensity of diffracted beam \(Continued...\) and X-ray diffraction profile and analysis](#)
- [Lecture 57 - X-ray diffraction profile and analysis](#)
- [Lecture 58 - X-ray diffraction profile and analysis \(Continued...\)](#)
- [Lecture 59 - X-ray diffraction profile and analysis \(Continued...\)](#)
- [Lecture 60 - Electron backscatter diffraction \(EBSD\)](#)

Lecture 1 - Fundamentals of electrochemistry, definition of primary and secondary batteries

Lecture 2 - Primary batteries and Secondary batteries

Lecture 3 - Supercapacitors

Lecture 4 - Concepts of thermodynamics pertinent to electrochemical cells

Lecture 5 - Kinetics of electrochemical cells and structural characteristics of electrodes

Lecture 6 - Introduction to EMF, redox potential, Faraday law and Nernst's law

Lecture 7 - Terminology related to secondary battery : half-cell,full-cell, redox couple,positive

Lecture 8 - Measurements: Cyclic voltammetry, nominal voltage, capacity, rate performance

Lecture 9 - Impedance spectroscopy measurement and analyses

Lecture 10 - Measurement of rechargeable cell: Case study

Lecture 11 - History and categories of lithium batteries

Lecture 12 - Operational mechanisms for lithium batteries: Intercalation materials, alloys

Lecture 13 - Differences of voltage profiles between intercalation materials, alloys, and conversion

Lecture 14 - Properties of electrode materials (Case study: alloy as anode)

Lecture 15 - Properties of electrode materials (conversion type oxide as case study)

Lecture 16 - Positive electrodes: Lithiated transition metal oxides, lithiated iron oxyphosphates etc

Lecture 17 - Negative electrodes: Carbonaceous materials, lithium titanium oxides etc

Lecture 18 - Electrolyte :Liquid Electrolyte, Polymer Electrolyte

Lecture 19 - Current Collector, Conductive Agents, Separator and Other Accessories

Lecture 20 - Novel materials for lithium ion rechargeable cells

Lecture 21 - Principle of Operation of Commercial Cells : viz. C - NMC, C - NCA etc

Lecture 22 - Principle of operation of commercial cells

Lecture 23 - Major characteristics of commercial Li ion cells: Cell performance,degradation phenomena

Lecture 24 - Fabrication of Li ion cell: Cylindrical configuration

Lecture 25 - Fabrication of Li ion cell: Pouch and prismatic cell

Lecture 26 - Positive electrodes: Layered oxide, polyanionic compounds (phosphates, sulphates etc)

Lecture 27 - Negative electrodes: Carbonaceous materials, alloy based and other materials

Lecture 28 - Electrolytes: Roles and requirements, organic electrolyte, ionic liquid electrolyte

Lecture 29 - Performance of Na ion rechargeable cell

Lecture 30 - Future perspective of Na ion cells

Lecture 31 - Introduction to battery module, BMS, thermal management and pack design

- Lecture 32 - Degradation and safety issues of Li ion rechargeable cells
- Lecture 33 - Introduction to battery management system: BMS topologies, hardware, concept of active
- Lecture 34 - Introduction to thermal management: Active thermal management system, passive thermal
- Lecture 35 - Packaging of battery pack and battery testing: Material selection, sealing of enclosure
- Lecture 36 - Classification of supercapacitors: EDLC and pseudocapacitive type
- Lecture 37 - Pseudocapacitor
- Lecture 38 - Asymmetric supercapacitor and BATCAP: Battery supercapacitor hybrid electrochemical
- Lecture 39 - Electrolytes for supercapacitors: Aqueous/organic liquid electrolytes/ionic liquid
- Lecture 40 - Current collectors, separators etc. and their effect on performance
- Lecture 41 - Operational principles of aqueous and Li - O<sub>2</sub> batteries
- Lecture 42 - Electrolytes for Li - O<sub>2</sub> batteries
- Lecture 43 - Limitations of Li - Air batteries
- Lecture 44 - State of the art Li - Air batteries : Carbonaceous materials
- Lecture 45 - State of the art Li - Air batteries: Case study
- Lecture 46 - The element sulfur, principle of operation
- Lecture 47 - Advantages and disadvantages of Li - S batteries, positive electrodes
- Lecture 48 - Electrolyte and negative electrode for Li - S battery
- Lecture 49 - State of the art Li - S batteries : Case study - I
- Lecture 50 - State of the art Li - S batteries : Case study - II
- Lecture 51 - Global Geographic Distribution of Raw Lithium Resources
- Lecture 52 - Nature and geological origin of all potential lithium resources
- Lecture 53 - State of the art extraction techniques and known production reserves
- Lecture 54 - Recycling of lithium and other battery constituents from used battery
- Lecture 55 - Recycling of lithium and other battery constituents from used battery (Continued...)
- Lecture 56 - Lead Acid Batteries: Operational principles, main characteristics and applications
- Lecture 57 - Lead Acid Batteries: Operational principles, main characteristics and applications (Continued...)
- Lecture 58 - Ni-Cd and Ni-MeH Batteries: Operational principles, main characteristics and applications
- Lecture 59 - Redox flow battery vanadium redox battery, operational principle, and main characteristics
- Lecture 60 - Other Redox Flow Battery Technologies

Lecture 1 - Introduction

Lecture 2 - Texture and Anisotropy

Lecture 3 - Processing - Texture - Anisotropic Properties

Lecture 4 - Crystal Structure and Stereographic Projections

Lecture 5 - Utilization of Stereographic Projections

Lecture 6 - Diffraction and Bragg's Law

Lecture 7 - Structure Factor and Diffraction Extinction Criteria

Lecture 8 - Structure factor and diffraction extinction criteria (Continued...)

Lecture 9 - Pole figures

Lecture 10 - Pole figures (Continued...)

Lecture 11 - Inverse Pole Figures

Lecture 12 - Three Dimensional Texture Analysis

Lecture 13 - Euler Angles and ODFs

Lecture 14 - Euler Angles and ODFs (Continued...)

Lecture 15 - Euler Angles and ODFs (Continued...)

Lecture 16 - Euler Angles and ODFs (Continued...)

Lecture 17 - Symmetry Effects on Orientation Matrix

Lecture 18 - Euler Space and Orientation Matrices

Lecture 19 - Texture Fibre, Periodicity in Euler Space, Incomplete Pole Figures

Lecture 20 - Crystal Structures and Symmetry

Lecture 21 - Size of Euler Space in Relation to Crystal and Sample Symmetry

Lecture 22 - Macrottexture and Microtexture Measurements

Lecture 23 - Penetration Depth of X-ray, Neutron, e-1 and Basics of X-ray Generation

Lecture 24 - Characteristic X-ray, Absorption and Filters

Lecture 25 - Principles of pole figure measurements by X-ray diffraction

Lecture 26 - Texture Goniometer Components

Lecture 27 - Limitations and Errors in X-ray Texture Measurement and Corrections

Lecture 28 - Basics of Electron Microscopy - I

Lecture 29 - Basics of Electron Microscopy - II

Lecture 30 - Kikuchi Diffraction Pattern - I

Lecture 31 - Kikuchi Diffraction Pattern - II

- Lecture 32 - Quantitative Evaluation of Kikuchi Diffraction Pattern - I
- Lecture 33 - Quantitative evaluation of Kikuchi Diffraction Pattern - II
- Lecture 34 - Quantitative evaluation of Kikuchi Diffraction Pattern - III
- Lecture 35 - Analysis using the TSL-OIM software
- Lecture 36 - Analysis using the AZtec Crystal software
- Lecture 37 - Analysis using the ATEX software
- Lecture 38 - Introduction to solidification texture
- Lecture 39 - Solidification texture in Alloys
- Lecture 40 - Solidification texture in FCC, BCC, and HCP structures
- Lecture 41 - Phase Transformation Texture and Bain Strain
- Lecture 42 - Orientation Relationships between FCC and BCC / BCT
- Lecture 43 - Various Orientation Relationships and Variants
- Lecture 44 - Basic Mechanics of Polycrystal Plasticity
- Lecture 45 - Basic Mechanics of Polycrystal Plasticity (Continued...)
- Lecture 46 - A Metallurgist Point of View
- Lecture 47 - A Metallurgist Point of View (Continued...)
- Lecture 48 - Texture in FCC polycrystals
- Lecture 49 - Texture in BCC polycrystals - I
- Lecture 50 - Texture in BCC polycrystals - II
- Lecture 51 - Texture in HCP polycrystals - I
- Lecture 52 - Texture in HCP polycrystals - II
- Lecture 53 - Texture in HCP polycrystals - III
- Lecture 54 - Static recrystallization
- Lecture 55 - Dynamic recrystallization and recrystallization texture
- Lecture 56 - Dynamic recrystallization and grain refinement during hot large strain shear

- Lecture 1 - Classification of Mining and Bulk Solid Handling Systems
- Lecture 2 - Properties of bulk material vis-a-vis different bulk handling operations
- Lecture 3 - Fundamentals of BMH and Transport: Capacity and Productivity Concepts
- Lecture 4 - Bulk material handling in Processing plants: Crushing and Screening Flow Charts
- Lecture 5 - Introduction to Bulk Material Transport and Autonomous Vehicles
- Lecture 6 - Constructional Components: Trends of Developments
- Lecture 7 - Belt Conveyor Construction: Belting for Bulk Material Conveyor
- Lecture 8 - Idlers and Belt Cleaners
- Lecture 9 - Feeding and Discharging Devices
- Lecture 10 - Safety and Troubleshooting
- Lecture 11 - Size Selection and Power Calculation
- Lecture 12 - Principle of operations and applicability
- Lecture 13 - Basic Design Calculations
- Lecture 14 - Introduction to Pneumatic Conveying systems
- Lecture 15 - Design Calculations for Pneumatic Conveying
- Lecture 16 - Exercise with Basic Design Calculations
- Lecture 17 - Stackers and Reclaimers: Classification and Selection Criteria
- Lecture 18 - Stackers and Reclaimers: Comparison of Different Types
- Lecture 19 - Principles of Blending and Reclaiming
- Lecture 20 - Case studies of stacker and reclaimers application
- Lecture 21 - System Layout
- Lecture 22 - Introduction to Bin Bunker and Silo
- Lecture 23 - Introduction to Bunker
- Lecture 24 - Introduction to Silo
- Lecture 25 - Silo Failures and Maintenance
- Lecture 26 - Basics of Silo Design
- Lecture 27 - Feeder Selection and Design
- Lecture 28 - Crushers: Classification and selection
- Lecture 29 - Secondary Crushers
- Lecture 30 - Screen: Classification and Selection
- Lecture 31 - Monitoring and Maintenance of Processing Plant Equipment

- Lecture 32 - Concentration and Separation
- Lecture 33 - Fine Size Classification: Desliming and Cycloning
- Lecture 34 - Froth Flotation Techniques, Magnetic Separation, Jigs and Thickeners
- Lecture 35 - Jigs and Thickeners
- Lecture 36 - Coal Washery Equipment and Practices
- Lecture 37 - Classification and Selection
- Lecture 38 - Crusher Selection and Application
- Lecture 39 - Off-Highway trucks and Haul Roads - 1
- Lecture 40 - Off-Highway trucks and Haul Roads - 2
- Lecture 41 - Recent Developments in Truck Transportation
- Lecture 42 - RopeCon Transportation
- Lecture 43 - Aerial Ropeways: Introduction
- Lecture 44 - Aerial Ropeways Calculation
- Lecture 45 - Pipe Conveyor Belt: Enclosed Material Transport
- Lecture 46 - Underground Mine Transport System
- Lecture 47 - Rope Haulage for Underground Mine Transport
- Lecture 48 - Main and Tail and Endless Rope Haulage
- Lecture 49 - Pit Top and Pit Bottom Layout
- Lecture 50 - Haulage calculation
- Lecture 51 - Locomotive
- Lecture 52 - Low Profile Dumper
- Lecture 53 - Load Haul Dumper
- Lecture 54 - Introduction to Cage and Skip Winding
- Lecture 55 - Winding Calculations
- Lecture 56 - Safety Aspects in Bulk Solid Handling and Transportation
- Lecture 57 - Safety Aspects in Bulk Solid Handling and Transportation
- Lecture 58 - Basic Introduction of Automatic Control
- Lecture 59 - Automating Bulk Solids Processes
- Lecture 60 - Online Monitoring



- Lecture 1 - Introduction to Materials and Environment
- Lecture 2 - Genesis of Materials Degradation
- Lecture 3 - Classification of degradation and Parameters Influencing it - Part I
- Lecture 4 - Parameters Influencing Degradation - Part II
- Lecture 5 - Engineering Solution to Combat Environmental Degradation of Materials
- Lecture 6 - Aqueous corrosion-thermodynamics of Wet Corrosion
- Lecture 7 - Aqueous corrosion-Classification - Part I
- Lecture 8 - Aqueous corrosion-Classification - Part II
- Lecture 9 - Classification of Aqueous corrosion - Part III
- Lecture 10 - Classification of Aqueous corrosion - Part IV
- Lecture 11 - Friction and Wear-Part - I
- Lecture 12 - Friction and Wear-Part - II
- Lecture 13 - Wear- Classification of wear - Part I
- Lecture 14 - Wear- Classification of wear - Part II
- Lecture 15 - Fatigue – Surface Dependent Property
- Lecture 16 - Failure Analysis - Part I
- Lecture 17 - Failure Analysis - Part II
- Lecture 18 - Characteristics of Failure - Part I
- Lecture 19 - Characteristics of Failure - Part II
- Lecture 20 - Characteristics of Failure - Part III
- Lecture 21 - Prevention
- Lecture 22 - Prevention of Chemical/Electrochemical Degradation
- Lecture 23 - Prevention of Chemical/Electrochemical Degradation (Continued...)
- Lecture 24 - Prevention of Chemical/Electrochemical Degradation (Continued...)
- Lecture 25 - Prevention of Mechanical Degradation
- Lecture 26 - Non Destructive Testing
- Lecture 27 - Mechanical and Electrochemical Testing - Part I
- Lecture 28 - Mechanical and Electrochemical Testing - Part II
- Lecture 29 - Mechanical and Electrochemical Testing - Part III
- Lecture 30 - Characterization
- Lecture 31 - Surface/Interface

- Lecture 32 - Scope, Classification and Objectives of Surface Engineering
- Lecture 33 - Shot Peening
- Lecture 34 - Grinding and Polishing
- Lecture 35 - Ultrasonic Peening and Laser Shock Peening
- Lecture 36 - Conventional Surface Hardening (Flame and induction)
- Lecture 37 - Pack Carburizing
- Lecture 38 - Fluidized Bed Carburizing
- Lecture 39 - Fused bath and Gas Nitriding
- Lecture 40 - Plasma Nitriding
- Lecture 41 - Diffusion Based Coatings - Solid State
- Lecture 42 - Chemical Conversion Coatings
- Lecture 43 - Electrodeposition
- Lecture 44 - Electrophoretic and Electroless deposition
- Lecture 45 - Galvanizing and Hot Dipping
- Lecture 46 - Thick Coatings by Weld Overlay and Cladding
- Lecture 47 - Introduction to thin film deposition
- Lecture 48 - Physical Vapor Deposition including Sputtering
- Lecture 49 - Chemical Vapor Deposition (CVD) and Composite Coating
- Lecture 50 - Chemical Vapor Deposition (CVD) and Composite Coating
- Lecture 51 - Spray Coating Techniques II - Plasma Spray and Cold Spray
- Lecture 52 - Ion Implantation
- Lecture 53 - Electron Beam Assisted Surface Engineering
- Lecture 54 - Laser Material Processing
- Lecture 55 - Laser Surface Engineering
- Lecture 56 - Laser Assisted Additive Manufacturing, LAM
- Lecture 57 - Strengthening Mechanisms in Surface Engineering
- Lecture 58 - Microstructural Characterization after Surface Engineering
- Lecture 59 - Compositional Characterization after Surface Engineering
- Lecture 60 - Summary of surface engineering and Conclusion

Lecture 1 - Modes of Fracture

Lecture 2 - Theoretical Strengths and Defects

Lecture 3 - Stress Concentration

Lecture 4 - Griffith Criterion

Lecture 5 - Griffith Criteria - Modification

Lecture 6 - Stress Intensity Factor

Lecture 7 - Fracture Toughness and Plane Stress-Plane Strain

Lecture 8 - Plastic Zone Size

Lecture 9 - Plane stress and plane strain fracture toughness

Lecture 10 - Plane stress and plane strain fracture toughness (Continued...)

Lecture 11 - Plane Strain Fracture Toughness Testing

Lecture 12 - Plane Strain-Plane Stress Fracture Toughness Testing

Lecture 13 - Plane Stress Fracture Toughness

Lecture 14 - Plane Stress fracture toughness-J integral

Lecture 15 - Experimental determination of JIC

Lecture 16 - J-integral and JIC

Lecture 17 - Impact Toughness

Lecture 18 - Impact Toughness (Continued...)

Lecture 19 - Impact Toughness (Continued...)

Lecture 20 - Impact Toughness (Continued...)

Lecture 21 - Impact Toughness (Continued...)

Lecture 22 - Fracture Toughness

Lecture 23 - Fracture Toughness (Continued...)

Lecture 24 - Fracture Toughness (Continued...)

Lecture 25 - Fracture Toughness (Continued...)

Lecture 26 - Fracture Toughness (Continued...)

Lecture 27 - Environment Assisted Fracture

Lecture 28 - Environment Assisted Fracture (Continued...)

Lecture 29 - Environment Assisted Fracture (Continued...)

Lecture 30 - Introduction to Fatigue

Lecture 31 - Stress Controlled Fatigue

- [Lecture 32 - Stress Controlled Fatigue \(Continued...\)](#)
- [Lecture 33 - Stress Controlled Fatigue \(Continued...\)](#)
- [Lecture 34 - Stress Controlled Fatigue \(Continued...\)](#)
- [Lecture 35 - Strain Controlled Fatigue \(Continued...\)](#)
- [Lecture 36 - Strain Controlled Fatigue \(Continued...\)](#)
- [Lecture 37 - Strain Controlled Fatigue \(Continued...\)](#)
- [Lecture 38 - Strain Controlled Fatigue \(Continued...\)](#)
- [Lecture 39 - Fatigue Crack Nucleation](#)
- [Lecture 40 - Notch Effect](#)
- [Lecture 41 - Crack in Fatigue](#)
- [Lecture 42 - Fatigue Crack Propagation](#)
- [Lecture 43 - Fatigue Crack Propagation \(Continued...\)](#)
- [Lecture 44 - Fatigue Crack Propagation \(Continued...\)](#)
- [Lecture 45 - Fatigue Crack Propagation \(Continued...\)](#)
- [Lecture 46 - Fatigue Crack Propagation \(Continued...\)](#)
- [Lecture 47 - Fatigue Crack Propagation \(Continued...\)](#)
- [Lecture 48 - Fatigue in Materials](#)
- [Lecture 49 - Fatigue in Materials \(Continued...\)](#)
- [Lecture 50 - Effect of Temperature on Fatigue](#)
- [Lecture 51 - Failure Analysis](#)
- [Lecture 52 - Failure Analysis \(Continued...\)](#)
- [Lecture 53 - Failure Analysis \(Continued...\)](#)
- [Lecture 54 - Failure Analysis - Case study - Titanic](#)
- [Lecture 55 - Failure Analysis - Case Study - ALK](#)
- [Lecture 56 - Failure Analysis - Case study - Point Pleasant Bridge](#)
- [Lecture 57 - Failure Analysis - Case Study - Rail Crash](#)
- [Lecture 58 - Failure Analysis - Case Study - Comet](#)
- [Lecture 59 - Failure Analysis - Case Study - Columbia](#)
- [Lecture 60 - Failure Analysis - Summary](#)

- Lecture 1 - Introduction to closure concept
- Lecture 2 - Mine Closure Objectives and Regulatory Aspects
- Lecture 3 - Mining Footprint and Regulatory Aspects
- Lecture 4 - Mine Closure Costs and Financing Approaches
- Lecture 5 - Decommissioning of Mines
- Lecture 6 - Demolition Techniques
- Lecture 7 - Post Closure Liabilities and Activities
- Lecture 8 - Post Closure Community Concerns and Sustainable Development Plans
- Lecture 9 - Closure oriented Resource Development-Post Mining Land Uses
- Lecture 10 - Post mining site monitoring
- Lecture 11 - Planning inputs, tools and techniques
- Lecture 12 - Tools and Techniques for Closure Plan Development and Procedures
- Lecture 13 - Closure Plan Development Procedures
- Lecture 14 - Monitoring, Review and Feedback of Closure Plan Implementation-Closure Criteria
- Lecture 15 - Failure Mode and Effect Analysis Framework for Mine Closure Planning
- Lecture 16 - Multiple Accounts Analysis (MAA) for Assessment of Closure Alternatives
- Lecture 17 - Provisioning of capital
- Lecture 18 - Closure costs and Rehabilitation Costs
- Lecture 19 - Finance and Accounting: Closure cost estimate
- Lecture 20 - Closure Economics and Audit
- Lecture 21 - Application of Remote Sensing for Mine Closure-Introduction
- Lecture 22 - Remote Sensing Sensors
- Lecture 23 - Remote Sensing media and sensors
- Lecture 24 - Image Processing and Data Interpretation
- Lecture 25 - GIS for Mine Closure: Mapping and Geo-Spatial Data Analysis
- Lecture 26 - Integration of phase operations
- Lecture 27 - Integration of Interdepartmental work and phase operations - Part 1
- Lecture 28 - Integration of Interdepartmental work and phase operations - Part 2
- Lecture 29 - Risk Analysis Techniques and Management
- Lecture 30 - Post Mine Closure Waste to Wealth Conversion
- Lecture 31 - CSR and EMP Integration

- Lecture 32 - Introduction to Asset Management
- Lecture 33 - Principle of Asset Management and Decommissioning of Assets for Site Restoration
- Lecture 34 - Brownfield Redevelopment and Value Addition to Assets
- Lecture 35 - Landform Design and Post Mining Asset Creation
- Lecture 36 - Concept of Sustainable Development and Mining industry
- Lecture 37 - Sustainability Measurement and Reporting
- Lecture 38 - Sustainability Measurement and Reporting (Continued...)
- Lecture 39 - Sustainable Mineral Industry
- Lecture 40 - Policy and Legislative Framework of Sustainability for SDG and Mine Closure
- Lecture 41 - Communicating sustainability performance
- Lecture 42 - Framework of Sustainability reporting
- Lecture 43 - Sustainable accounting
- Lecture 44 - Case studies on Sustainability initiatives in Mining Industry
- Lecture 45 - Data Analytics for Sustainability management
- Lecture 46 - Cleaner Production Based Closure Management
- Lecture 47 - Regenerative environment design for sustainable Mine Closure
- Lecture 48 - Reusable resource identification in post closure mine site
- Lecture 49 - Optimization of Residual Value of Assets
- Lecture 50 - Post Mining Site for Community wealth
- Lecture 51 - Management of water resources
- Lecture 52 - Soil Treatment and Revegetation
- Lecture 53 - Bio-diversity: Post Land reclamation and plantation
- Lecture 54 - Physical and Chemical Stability issues
- Lecture 55 - Economic Utilization of Post Mining Structures and assets
- Lecture 56 - Techniques for closing underground workings
- Lecture 57 - Application of Industry 4.0 for Mine
- Lecture 58 - Best mining practices for Sustainable mining - Case studies
- Lecture 59 - Stability Monitoring and Enhancing tools
- Lecture 60 - VR and AR Technology for Post Mining Mine site Visualization and Design

- Lecture 1 - Fundamental aspects of hybrid materials
- Lecture 2 - Materials selection basics for design with hybrid materials
- Lecture 3 - Classes of materials and material property charts
- Lecture 4 - Material property charts and concept of material indices
- Lecture 5 - Material property chart-indices and concept of hybridization
- Lecture 6 - Hybrid materials - Composite
- Lecture 7 - Cellular solids - Applications of metal foams
- Lecture 8 - Cellular solids - Applications of porous ceramics and polymer foams
- Lecture 9 - Basics of Composite Materials and Classification
- Lecture 10 - Composite Classification - Matrix and Reinforcement
- Lecture 11 - Fibers - Fundamentals, Glass fiber
- Lecture 12 - Fibers - Boron and Carbon Fibers
- Lecture 13 - Fibers - Aramid and Ceramic fibers, Alumina fiber
- Lecture 14 - Fibers - SiC fiber and Whiskers
- Lecture 15 - Metal matrix composites (MMCs) - Basic concept, Liquid state processing
- Lecture 16 - Metal matrix composites (MMCs) - Liquid and Solid state processing
- Lecture 17 - Ceramic Matrix Composites (CMCs) - Basic concept, Processing techniques
- Lecture 18 - Ceramic Matrix Composites (CMCs) - Processing techniques
- Lecture 19 - CMCs and PMCs - Processing and Application
- Lecture 20 - Fabrication of cellular ceramics
- Lecture 21 - Sintering of ceramics - Aspects and mechanisms
- Lecture 22 - Fabrication of cellular ceramics
- Lecture 23 - Processing of metal foams - Foaming techniques
- Lecture 24 - Processing of metal foams (Continued...)
- Lecture 25 - Processing of metal foams (Continued...)
- Lecture 26 - Polymer foams - Processing and properties
- Lecture 27 - Additive manufacturing - Definition and Prospects
- Lecture 28 - Cellular solids classification and Structure description
- Lecture 29 - Structure of cellular solids - Pore structure characterization
- Lecture 30 - Interfacial phenomena - Basic concept, Adhesion and Wettability
- Lecture 31 - Interfacial phenomena - Factors affecting wettability

- Lecture 32 - Interfacial phenomena - Interfacial bonding
- Lecture 33 - Interfacial phenomena - Interfacial strength measurement
- Lecture 34 - Interfacial phenomena - Case study - Al-MWCNT nanocomposite
- Lecture 35 - Interfacial phenomena - Case studies: MMCs and CMCs
- Lecture 36 - Interfacial phenomena - Case studies: MMCs and CMCs (Continued...)
- Lecture 37 - Mechanics of Composites - Unidirectional Lamina
- Lecture 38 - Mechanics: Fiber-reinforced composites - Transverse Loading
- Lecture 39 - Mechanics: Fiber-reinforced composites - Problem Solving
- Lecture 40 - Mechanics: Fiber-reinforced composites - Discontinuous fibers
- Lecture 41 - Mechanics of Composites - Discontinuous fibers
- Lecture 42 - Dependence of properties on pore structure
- Lecture 43 - Mechanics of cellular solids
- Lecture 44 - Mechanics of cellular solids (Continued...)
- Lecture 45 - Deformation behavior of honeycomb and foams
- Lecture 46 - Deformation behaviour of Foams
- Lecture 47 - Deformation behaviour of Foams (Continued...)
- Lecture 48 - Deformation behaviour of Foams (Continued...)
- Lecture 49 - Thermal properties of foams
- Lecture 50 - Other important properties of foams (Continued...)
- Lecture 51 - Advanced composites - MMCs
- Lecture 52 - Advanced composites - MMCs (Continued...)
- Lecture 53 - Advanced composites - CMCs
- Lecture 54 - Advanced composites - Advanced Processing Techniques
- Lecture 55 - Advanced composites - Advanced Processing Techniques (Continued...)
- Lecture 56 - Advanced composites - Advanced Processing Techniques (Continued...)
- Lecture 57 - Advanced composites - Application oriented advanced composites
- Lecture 58 - Microstructure and properties of natural cellular solid - wood
- Lecture 59 - Advanced hybrid material - Functionally graded composite materials (FGMs)
- Lecture 60 - Advanced hybrid material - Functionally graded composite materials (FGMs) (Continued...)



- Lecture 1 - Introduction, Classification and Uses of Metals
- Lecture 2 - Introduction, Classification and Uses of Metals (Continued...)
- Lecture 3 - Occurrence/Source of Metals
- Lecture 4 - Metal Extraction Process Overview
- Lecture 5 - Mineral Beneficiation: Overview and Mass Balances
- Lecture 6 - Crushing and Grinding (Comminution)
- Lecture 7 - Mineral Classification: Separation in Flowing Fluid
- Lecture 8 - Mineral Concentration by Froth Flotation
- Lecture 9 - Mineral Concentration by Froth Flotation
- Lecture 10 - Magnetic and Electric Separation/Concentration
- Lecture 11 - Sensor-based/Automatic Ore Sorting
- Lecture 12 - Solid-Liquid Separation
- Lecture 13 - Particle Size Estimation and Screening
- Lecture 14 - Fuels in Metallurgical Processes and Coal Characteristics
- Lecture 15 - Calorific Value and Caking Properties of Coal
- Lecture 16 - Coke: Making and Properties
- Lecture 17 - Combustion of Fuels
- Lecture 18 - Combustion: Mass and Heat Balance
- Lecture 19 - Combustion Heat Balance: Flame Temperature
- Lecture 20 - Combustion Heat Utilization in Furnace
- Lecture 21 - Heat Utilization in Furnace: Numerical Examples
- Lecture 22 - Classification of Furnaces
- Lecture 23 - Refractories for Furnace Linings
- Lecture 24 - Refractories: Testing and Production
- Lecture 25 - Agglomeration of Fines: Pelletization and Briquetting
- Lecture 26 - Agglomeration of Fines: Sintering
- Lecture 27 - Extraction of Metal from Sulfides: Roasting
- Lecture 28 - Roasting Reactors and Heat Balance
- Lecture 29 - Roasting: Predominance Area Diagram
- Lecture 30 - Roasting: Application of Predominance Area Diagram
- Lecture 31 - Reduction Smelting and Matte Smelting

Lecture 32 - Metallurgical Slag

Lecture 33 - Slag Viscosity, Surface Tention and Theories

Lecture 34 - Slag: Masson and Molecular Theory, Numerical Examples

Lecture 35 - Copper Extraction: Matte Smelting

Lecture 36 - Copper Extraction: Flash Smelting

Lecture 37 - Cu Extraction: Cyclone Flash Smelting and Numerical Examples

Lecture 38 - Cu Extraction: Conversion

Lecture 39 - Conversion of Nickel Sulphide and Numerical Examples

Lecture 40 - TSL Smelting, Continuous Conversion and Direct Cu-Production

Lecture 41 - Reduction Smelting: Lead Extraction

Lecture 42 - Reduction Smelting: Zinc Extraction and ISP

Lecture 43 - Extraction of Tin, Tungsten, Molybdenum and Numerical Examples

Lecture 44 - Extraction of Nb, V, Ferroalloys and Titania (from Ilmenite)

Lecture 45 - Silicothermy: Pyrometallurgical Magnesium Extraction

Lecture 46 - Reduction Smelting: Iron Extraction in Blast Furnace

Lecture 47 - Alternative Routes of Iron Extraction

Lecture 48 - Halide Metallurgy: Extraction of Ti, Zr, Hf, U, Si Purification

Lecture 49 - Purification of Bulk Metals: Chemical Refining

Lecture 50 - Chemical Refining: Purification of Lead

Lecture 51 - Chemical Refining of Zinc, Tin, Nickel, Ti (Zr, Hf, Th)

Lecture 52 - Physical Refining: Vacuum De-gassing, Zone Melting and Distillation

Lecture 53 - Hydrometallurgy: Unit Steps, Leaching Reagents and Methods

Lecture 54 - Physiochemical Aspect of Leaching, Bacterial Leaching, S/L Separation

Lecture 55 - Hydrometallurgy: Solution Purification and Metal Ion Reduction

Lecture 56 - Hydrometallurgy: Cementation, Electrowinning, Au Extraction and Bayer Process

Lecture 57 - Electrometallurgy: Electrowinning, Electrorefining, Current and Energy Efficiency

Lecture 58 - Electrometallurgy: Extraction of Mg and Al

Lecture 59 - Environmental Concern and Sustainable Metal Extraction

Lecture 60 - New Development in Metal Extraction: Solvometallurgy, Bio-Metallurgy, Membrane Technology

Lecture 1 - Basic definitions

Lecture 2 - Free energy, Stability, equilibrium in a unary system

Lecture 3 - Effect of Pressure on equilibrium transformations: Clausius Clapeyron equation, phase diagram for unary system

Lecture 4 - Free energy of solutions, free energy-composition diagrams

Lecture 5 - Solution models, chemical potential

Lecture 6 - Phase rule, free energy-composition diagrams and phase diagrams

Lecture 7 - Evolution of phase diagrams

Lecture 8 - Evolution of phase diagrams, miscibility gap

Lecture 9 - To concept, partition less solidification

Lecture 10 - To concept, partition less solidification (Continued...)

Lecture 11 - Eutectic solidification, glass formation

Lecture 12 - Kauzmann paradox, order of a transformation, glass forming ability

Lecture 13 - Eutectic solidification, coupled growth, heterogeneous nucleation

Lecture 14 - Peritectic solidification, metastable phase diagrams

Lecture 15 - Errors in drawing phase diagrams, Fe-C vs. Fe-Fe<sub>3</sub>C phase diagram

Lecture 16 - Free energy of undercooled liquid, shape of nucleus

Lecture 17 - Solid state phase transformations - Precipitation

Lecture 18 - Precipitation

Lecture 19 - Precipitation - quasicrystals

Lecture 20 - Precipitate coarsening, stability of a phase, spinodal decomposition

Lecture 21 - Spinodal decomposition

Lecture 22 - Eutectoid reaction

Lecture 23 - Eutectoid reaction (Continued...)

Lecture 24 - Bainitic transformation

Lecture 25 - Kinetics of eutectoid transformations

Lecture 26 - Martensitic Transformation

Lecture 27 - Martensitic transformation, order-disorder transformation

Lecture 28 - Miscibility gap in phase diagrams

Lecture 29 - Phase diagram calculations

Lecture 30 - Thermodynamics of heterogeneous systems

Lecture 31 - Thermodynamics of heterogeneous systems (Continued...)



Lecture 1 - Properties of light, Image formation

Lecture 2 - Magnification and resolution

Lecture 3 - Depth of field, focus and field of view

Lecture 4 - Lens defects, filters and light microscopy introduction

Lecture 5 - Optical microscope demo., Bright field imaging, opaque specimen illumination

Lecture 6 - Opaque stop microscopy, Phase contrast microscopy

Lecture 7 - Dark field microscopy, Polarization microscopy

Lecture 8 - Differential interference contrast and fluorescence microscopy

Lecture 9 - Sample preparation techniques for optical microscopy

Lecture 10A - Tutorial problems (Continuation...)

Lecture 10 - Tutorial problems

Lecture 11 - Introduction to scanning electron Microscopy

Lecture 12 - Lens aberrations, Object resolution, Image quality

Lecture 13 - Interaction between electrons and sample, Imaging capabilities, Structural analysis, Elemental analysis

Lecture 14 - SEM and its mode of operation, Effect of aperture size, Working distance, condenser lens strength

Lecture 15 - SEM and its mode of operation- continuation, Relation between probe current and probe diameter, Summary

Lecture 16 - Factors affecting Interaction volume, Demonstration of SEM

Lecture 17 - Image formation and interpretation

Lecture 18 - Image formation and interpretation continued, EDS, WDS

Lecture 19 - Special contrast mechanisms, Monte Carlo simulations of Interaction volume

Lecture 20 - Electron channeling contrast imaging (ECCI), Electron back scattered diffraction (EBSD)-Theory & instrument demonstration

Lecture 21 - Tutorial Problems on SEM

Lecture 22 - Basics of X-ray emission from source, electron excitation and X-ray interaction with materials in general

Lecture 23 - Properties of X-rays

Lecture 24 - Bragg's Law Derivation

Lecture 25 - Diffraction relationship with reciprocal space

Lecture 26 - X-ray scattering

Lecture 27 - Factors affecting intensities of X-ray peaks

Lecture 28 - Factors affecting intensities of X-ray peaks- continuation

Lecture 29 - Effect of crystallite size and strain on intensity of X-rays

Lecture 30 - Profile fit, Factors affecting peak broadening

Lecture 31 - Indexing of diffraction pattern, Quantitative analysis

Lecture 32 - Indexing, Quantitative analysis-continuation, Residual stress measurements

Lecture 33 - XRD and Residual stress measurement- lab demonstration

Lecture 34 - Introduction to Transmission Electron Microscopy (TEM)

Lecture 35 - Fundamentals of Transmission Electron Microscopy (TEM)

Lecture 36 - Basics of Diffraction-1

Lecture 37 - Basics of Diffraction-2

Lecture 38 - TEM imaging-1

Lecture 39 - TEM imaging-2

Lecture 40 - TEM instrument demonstration

Lecture 41 - TEM sample preparation-1

Lecture 42 - TEM sample preparation-2

Lecture 43 - XRD Tutorial - 1

Lecture 44 - XRD tutorial - 2

Lecture 45 - TEM Tutorial - 1

Lecture 46 - TEM Tutorial - 2

Lecture 47 - Quantitative metallography - Tutorial 1

Lecture 48 - Quantitative metallography - Tutorial 2

Lecture 49 - Quantitative metallography - Tutorial 3

Lecture 50 - Quantitative metallography - Tutorial 4

Lecture 51 - Quantitative metallography - Tutorial 5

Lecture 52 - Quantitative metallography - Tutorial 6

Lecture 53 - Quantitative metallography - Tutorial 7

Lecture 1 - Introduction

Lecture 2 - Properties of Materials

Lecture 3 - Thermal Expansion

Lecture 4 - Measuring Electrical Conductivity: DC and AC

Lecture 5 - Free Electron Gas

Lecture 6 - The Ideal Gas

Lecture 7 - Drude Model: Electrical Conductivity

Lecture 8 - Drude Model: Thermal Conductivity

Lecture 9 - Drude Model: Successes and Limitations

Lecture 10 - Drude Model: Source of Shortcomings

Lecture 11 - Large Systems and Statistical Mechanics

Lecture 12 - Maxwell Boltzmann Statistics

Lecture 13 - Classical Particles and Quantum Particles

Lecture 14 - History of Quantum Mechanics - 1

Lecture 15 - History of Quantum Mechanics - 2

Lecture 16 - Introduction to Drude Sommerfeld model

Lecture 17 - Fermi-Dirac Statistics - Part 1

Lecture 18 - Fermi-Dirac Statistics - Part 2

Lecture 19 - Features of the Fermi Dirac Distribution Function

Lecture 20 - Maxwell-Boltzmann Distribution Vs Fermi-Dirac Distribution

Lecture 21 - Anisotropy and Periodic Potential in a Solid

Lecture 22 - Confinement and Quantization - Part 1

Lecture 23 - Confinement and Quantization - Part 2

Lecture 24 - Density of States

Lecture 25 - Fermi Energy, Fermi Surface, Fermi Temperature

Lecture 26 - Electronic Contribution to Specific Heat at Constant Volume

Lecture 27 - Reciprocal Space-1: Introduction to Reciprocal Space

Lecture 28 - Reciprocal Space-2: Condition for Diffraction

Lecture 29 - Reciprocal Space-3: Ewald sphere, Simple Cubic, FCC and BCC in Reciprocal Space

Lecture 30 - Wigner Seitz Cell and Introduction to Brillouin Zones

Lecture 31 - Brillouin Zones, Diffraction, and Allowed Energy Levels

[Lecture 32 - E Vs k, Brillouin Zones and the Origin of Bands](#)

[Lecture 33 - Calculating Allowed Energy Bands and Forbidden Band Gaps](#)

[Lecture 34 - Bands; Free Electron Approximation, Tight Binding Approximation](#)

[Lecture 35 - Semiconductors](#)

[Lecture 36 - Magnetic Properties](#)

[Lecture 37 - Electron Compounds; Phonons, Optoelectronic Materials](#)

[Lecture 38 - Superconductivity](#)

[Lecture 39 - Bose-Einstein Statistics](#)

[Lecture 40 - Physics of Nano Scale Materials; Course Summary](#)



- Lecture 1 - Metals, semiconductors and insulators
- Lecture 2 - Introduction to semiconductors
- Lecture 3 - Density of states and Fermi-Dirac statistics
- Lecture 4 - Assignment 1 - Bonding, DOS, and Fermi statistics
- Lecture 5 - Intrinsic semiconductors
- Lecture 6 - Intrinsic semiconductors - conductivity
- Lecture 7 - Assignment 2 - Intrinsic semiconductors
- Lecture 8 - Extrinsic semiconductors
- Lecture 9 - Extrinsic semiconductors - Fermi level
- Lecture 10 - Extrinsic semiconductors - conductivity
- Lecture 11 - Assignment 3 - Extrinsic semiconductors
- Lecture 12 - Metal-semiconductor junctions
- Lecture 13 - Assignment 4 - Metal-semiconductor junctions
- Lecture 14 - pn junctions in equilibrium
- Lecture 15 - pn junctions under bias
- Lecture 16 - pn junction breakdown and heterojunctions
- Lecture 17 - Assignment 5 - pn junctions
- Lecture 18 - Transistors
- Lecture 19 - MOSFETs
- Lecture 20 - Assignment 6 - transistors
- Lecture 21 - Optoelectronic devices: Introduction
- Lecture 22 - Optoelectronic devices: LEDs
- Lecture 23 - Optoelectronic devices: LASERS
- Lecture 24 - Optoelectronic devices: photodetector
- Lecture 25 - Optoelectronic devices: solar cells
- Lecture 26 - Assignment 7 - optical properties
- Lecture 27 - Assignment 8 - optoelectronic devices
- Lecture 28 - Semiconductor manufacturing: Introduction
- Lecture 29 - Si wafer manufacturing
- Lecture 30 - IC device manufacturing: overview
- Lecture 31 - Layering: thermal oxidation

[Lecture 32 - Doping: thermal and ion implantation](#)

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[Lecture 34 - Etching and deposition \(growth\)](#)

[Lecture 35 - Metallization and polishing](#)

[Lecture 36 - Process and device evaluation](#)

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[Lecture 38 - Clean room design and contamination control](#)

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Lecture 7 - Dark field microscopy, Polarization microscopy

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Lecture 10 - Tutorial problems

Lecture 11 - Tutorial problems (Continued...)

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Lecture 22 - Tutorial Problems on SEM

- Lecture 1 - Electronic Materials
- Lecture 2 - Semiconductors - Introduction
- Lecture 3 - Electron statistics in a solid
- Lecture 4 - Worked numericals on week 1 lessons
- Lecture 5 - Intrinsic semiconductors
- Lecture 6 - Intrinsic semiconductors - conductivity
- Lecture 7 - Optional - worked assignment on intrinsic semiconductors
- Lecture 8 - Extrinsic semiconductors - Introduction
- Lecture 9 - Extrinsic semiconductors - Fermi level
- Lecture 10 - Extrinsic semiconductors - Mobility
- Lecture 11 - Worked assignment on extrinsic semiconductors
- Lecture 12 - Metal-semiconductor junctions
- Lecture 13 - pn junctions in equilibrium
- Lecture 14 - Optional - worked assignment on metal-semiconductor junctions
- Lecture 15 - pn junctions under bias
- Lecture 16 - Junction breakdown and heterojunctions
- Lecture 17 - Worked assignment on pn junctions
- Lecture 18 - Transistors - overview
- Lecture 19 - MOSFETs
- Lecture 20 - Worked assignment on transistors
- Lecture 21 - Optoelectronic devices - Introduction
- Lecture 22 - Light emitting diodes
- Lecture 23 - Solid state semiconductor lasers
- Lecture 24 - Optional - worked assignment on optical properties
- Lecture 25 - Photodetectors
- Lecture 26 - Solar cells
- Lecture 27 - Worked assignment on optoelectronic devices

Lecture 1 - Reciprocal space; Definition and Properties

Lecture 2 - Condition for Diffraction

Lecture 3 - Worked out examples

Lecture 4 - Ewald Sphere and lattices in reciprocal space

Lecture 5 - Wigner Sietz cells and Brillouin Zones

Lecture 6 - Worked out exmaples

Lecture 7 - Brillouin Zones, Diffraction and allowed energy levels

Lecture 8 - E Vs K, Brillouin zones and the Origin of Bands

Lecture 9 - Week 3 Worked out examples

Lecture 10 - Reciprocal space as Fourier transform of real lattice

Lecture 11 - Alternate notation of reciprocal space

Lecture 1 - Introduction to fusion welding processes: Part 1/2

Lecture 2 - Introduction to fusion welding processes: Part 2/2

Lecture 3 - Heat sources - Part 1/2

Lecture 4 - Heat sources - Part 2/2

Lecture 5 - Heat removal

Lecture 6 - Thermal Modelling - Part 1/2

Lecture 7 - Thermal Modelling - Part 2/2

Lecture 8 - Zones in a weldment

Lecture 9 - Analytical Solutions to Weld Thermal Field

Lecture 10 - Conduction to Keyhole mode

Lecture 11 - Fluid flow modelling - Part 1/2

Lecture 12 - Fluid flow modelling - Part 2/2

Lecture 13 - Solute transfer modelling - Part 1/2

Lecture 14 - Solute transfer modelling - Part 2/2

Lecture 15 - Solute segregation profile - Part 1/2

Lecture 16 - Solute segregation profile - Part 2/2

Lecture 17 - Microstructure Formation in Fusion Welds

Lecture 18 - Numerical Solutions to Thermal Field and Fluid Flow in Welding - Part 1

Lecture 19 - Numerical Solutions to Thermal Field and Fluid Flow in Welding - Part 2

Lecture 20 - Dissimilar Welding

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Lecture 2 - Properties of X-rays

Lecture 3 - Bragg's law derivation

Lecture 4 - Diffraction relationship with reciprocal space

Lecture 5 - X-ray scattering

Lecture 6 - Factors affecting intensities of X-ray peaks

Lecture 7 - Factors affecting intensities of X-ray peaks (Continued...)

Lecture 8 - Effect of crystallite size and strain on intensity of X-rays

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Lecture 10 - Indexing of diffraction pattern, Quantitative analysis

Lecture 11 - Indexing and Quantitative analysis-continuation, Residual stress measurements

Lecture 12 - XRD and Residual stress measurement - lab demonstration

Lecture 13 - XRD Tutorial - 1

Lecture 14 - XRD tutorial - 2

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Lecture 16 - Fundamentals of Transmission Electron Microscopy (TEM)

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Lecture 18 - Basics of Diffraction - 2

Lecture 19 - TEM Imaging - 1

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Lecture 22 - TEM sample preparation - 1

Lecture 23 - TEM sample preparation - 2

Lecture 24 - TEM Tutorial - 1

Lecture 25 - TEM Tutorial - 2

Lecture 26 - TEM Tutorial - 3

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Lecture 31 - Microencapsulation Processes

[Lecture 32 - Microencapsulation: Kinetics of release](#)

[Lecture 33 - Plating of Nanocomposite Coatings - I](#)

[Lecture 34 - Plating of Nanocomposite Coatings - II](#)

[Lecture 35 - Advantages of Microencapsulation over Other Conventional Methods](#)

[Lecture 36 - Current Trends in Surface Modification of Nanomaterials - Part-1](#)

[Lecture 37 - Current Trends in Surface Modification of Nanomaterials - Part-2](#)

[Lecture 38 - Current Trends in Surface Modification of Nanomaterials - Part-3](#)

[Lecture 39 - Modified Nanomaterials: In-use for consumer products](#)

[Lecture 40 - Main Problems in Synthesis of Modified Nanomaterials](#)

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Lecture 2 - Atomic structure and bonding

Lecture 3 - Crystal systems and structures: Lattice

Lecture 4 - X-ray diffraction: Crystal structure determination

Lecture 5 - Crystal planes and directions: Indexing

Lecture 6 - Optical microscope

Lecture 7 - Optical aberration

Lecture 8 - Metallography

Lecture 9 - Microstructure: Understanding

Lecture 10 - Quantitative metallography

Lecture 11 - Crystallographic defects

Lecture 12 - Diffusion

Lecture 13 - Phase diagram - 1

Lecture 14 - Phase diagram - 2

Lecture 15 - Eutectic phase diagram

Lecture 16 - Equilibrium and non-equilibrium cooling

Lecture 17 - Equilibrium cooling of eutectic system

Lecture 18 - Solidification structure

Lecture 19 - Iron-carbon phase diagram

Lecture 20 - Nucleation and growth

Lecture 21 - TTT and CCT curves

Lecture 22 - Heat treatment

Lecture 23 - Precipitation

Lecture 24 - Elastic behaviour

Lecture 25 - Tensile test

Lecture 26 - Engineering and true stress and strain

Lecture 27 - Plastic deformation - 1

Lecture 28 - Plastic deformation - 2

Lecture 29 - Strengthening mechanism - 1

Lecture 30 - Strengthening mechanism - 2

Lecture 31 - Strengthening mechanism - 3



[Lecture 32 - Strengthening mechanism - 4](#)

[Lecture 33 - Fracture: Part - 1](#)

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[Lecture 37 - NDT: Hardness measurement](#)

[Lecture 38 - Ceramics, polymers, composites](#)

[Lecture 39 - Electrical and magnetic properties](#)

[Lecture 40 - Alloy designation and properties](#)

Lecture 1 - Introduction

Lecture 2 - Structure of Materials

Lecture 3 - Imperfections in Structure of Materials

Lecture 4 - Phase Diagram: Determination of Phases

Lecture 5 - Transformation of Phases

Lecture 6 - Basic Properties: Metals - I

Lecture 7 - Basic Properties: Metals - II

Lecture 8 - Basic Properties: Ceramics

Lecture 9 - Basic Properties: Polymers

Lecture 10 - Selection of Nanomaterials based on Applications

Lecture 11 - Introduction to X-Ray Diffraction

Lecture 12 - Diffraction Methods and Directions of XRD

Lecture 13 - Determination of Crystal Structures by XRD Patterns

Lecture 14 - Precise Parameter Measurements

Lecture 15 - Orientation of Single Crystals

Lecture 16 - Qualitative Analysis by Diffraction

Lecture 17 - Quantitative Analysis by Diffraction

Lecture 18 - Microscopic Structural Analysis of Nanomaterials - I

Lecture 19 - Microscopic Structural Analysis of Nanomaterials - II

Lecture 20 - Other Characterization Techniques

# DIGIMAT - The No.1 Learning Management Platform for Creative Learning

**NPTEL : NOC:Thermo-Mechanical and Thermo-Chemical Processes (Metallurgy and Material Science)**

**Co-ordinators : Prof. S. R. Meka**

Lecture 1 - Introduction to Thermomechanical Processes

Lecture 2 - Conventional Thermomechanical Processes

Lecture 3 - Non-conventional Thermomechanical Processes

Lecture 4 - Stress and Strain

Lecture 5 - Effect of Strain Rate and Temperature

Lecture 6 - Microstructure Evolution

Lecture 7 - Dynamic Recovery

Lecture 8 - Discontinuous Dynamic Recrystallization

Lecture 9 - Dynamic Recrystallization : Critical Stress and Strain

Lecture 10 - Continuous Dynamic Recrystallization (CDRX) and Geometrical Dynamic Recrystallization (GDRX)

Lecture 11 - Stereographic Projection

Lecture 12 - Using Stereographic Projection

Lecture 13 - Crystallographic Texture

Lecture 14 - Crystallographic Texture: Texture Components

Lecture 15 - Crystallographic Texture: Application

Lecture 16 - Constitutive Analysis

Lecture 17 - Constitutive Analysis: Low Strain Rate

Lecture 18 - Higher Strain Rate: Hot Working

Lecture 19 - Constitutive Based Model : Physical Based Model

Lecture 20 - Constitutive analysis : Case Study

Lecture 21 - Processing Maps : Deformation Mechanism maps

Lecture 22 - Processing Maps : Dynamic Material Model

Lecture 23 - Microstructure and Application

Lecture 24 - Processing Maps : Different Models

Lecture 25 - Processing Maps : Case Study

Lecture 26 - Equal Channel Angular Pressing (ECAP)

Lecture 27 - Friction Stir Processing (FSP)

Lecture 28 - Accumulative Roll Bonding (ARB)

Lecture 29 - Multi Axial Forging (MAF)

Lecture 30 - Severe Plastic Deformation : Case Study

Lecture 31 - Overview on Thermo-Chemical treatments

[Lecture 32 - Overview on Thermo-Chemical treatments \(Continued...\)](#)

[Lecture 33 - Thermodynamic aspects of thermo-chemical treatments: Preliminaries](#)

[Lecture 34 - Thermodynamics of Gaseous Nitriding - I](#)

[Lecture 35 - Thermodynamics of Gaseous Nitriding - II](#)

[Lecture 36 - Gaseous Nitriding of Pure Iron](#)

[Lecture 37 - Gaseous Nitriding of Iron based alloys](#)

[Lecture 38 - Duplex and Dual Phase microstructures through nitriding](#)

[Lecture 39 - Alloying element nitride precipitation during nitriding of iron based alloys](#)

[Lecture 40 - Kinetics of gaseous nitriding](#)

Lecture 1 - Introduction to welding metallurgy

Lecture 2 - Overview of Welding Processes

Lecture 3 - Introduction to phase diagrams

Lecture 4 - Phase diagram of Iron Carbon system

Lecture 5 - Phase diagram of non ferrous metals and alloys

Lecture 6 - Phase Transformations

Lecture 7 - Time Temperature Transformation Diagrams

Lecture 8 - Continuous Cooling Transformation Diagrams

Lecture 9 - Carbon Equivalent, Schaeffler Diagrams

Lecture 10 - Problem solving on Phase Diagrams

Lecture 11 - Introduction to strengthening mechanism in metals

Lecture 12 - Solid solution strengthening and grain refinement

Lecture 13 - Precipitation Hardening and Martensite Strengthening

Lecture 14 - Strain Hardening and Strain Ageing

Lecture 15 - Problem solving on strengthening mechanism in metals

Lecture 16 - Introduction to Heat treatment Processes in Welding

Lecture 17 - Hardening and Hardenability

Lecture 18 - Martempering and Austempering

Lecture 19 - Case Hardening methods

Lecture 20 - Heat treatment of Non-Ferrous metals and alloys

Lecture 21 - Heat Sources in Welding

Lecture 22 - Heat Flow in Welding

Lecture 23 - Temperature Distribution in Welding

Lecture 24 - Effect of Welding Parameters

Lecture 25 - Metallurgical effect of Heat Flow on Welding

Lecture 26 - Principles of Solidification in Welding

Lecture 27 - Solute redistribution during Solidification

Lecture 28 - Constitutional Supercooling

Lecture 29 - Microsegregation and Banding

Lecture 30 - Grain Structure during Solidification in Welding

Lecture 31 - Distinct Zones in Fusion Welded Specimen

Lecture 32 - Heat Affected Zone

Lecture 33 - Properties of Heat Affect Zone

Lecture 34 - Microstructural Products in Weldments

Lecture 35 - Introduction to Preheat and Postweld Heat Treatment

Lecture 36 - Preheat and Postweld Heat Treatment of Different Materials

Lecture 37 - Residual Stresses in Welding

Lecture 38 - Causes of Residual Stress Development in Welding

Lecture 39 - Measurement of Residual Stresses in Weldments

Lecture 40 - Controlling Residual Stresses in Weldments

Lecture 41 - Introduction to Welding Distortion

Lecture 42 - Types of Welding Distortions

Lecture 43 - Angular Distortions in Welds

Lecture 44 - Bowing, Buckling and Twisting in Welds

Lecture 45 - Control of Distortion in Welds

Lecture 46 - Introduction to Cracks in Welds

Lecture 47 - Types of Weld Cracks

Lecture 48 - Specific Weld Cracks

Lecture 49 - Chevron Cracks and Reheat Cracks

Lecture 50 - Lamellar Cracks and Stress Corrosion Cracking

Lecture 51 - Introduction to Weldability of Metals

Lecture 52 - Weldability of Carbon Steels

Lecture 53 - Weldability of Alloy Steels

Lecture 54 - Weldability of Cast Iron

Lecture 55 - Weldability of Non Ferrous Metals and Alloys

Lecture 56 - Introduction to Welding Defects

Lecture 57 - Surface and Subsurface Welding Defects

Lecture 58 - Issues in Welding: Design for Static Loading

Lecture 59 - Considerations for Fatigue Loading in Welding

Lecture 60 - Design Features for Fatigue and Static Loading in Welding

- Lecture 1 - Introduction to Continuous Casting Process
- Lecture 2 - Role of Tundish in Continuous Casting
- Lecture 3 - Types of Continuous Casting Machine
- Lecture 4 - Components of Continuous Casting Unit
- Lecture 5 - Tundish Metallurgy
- Lecture 6 - Introduction to Physical Modeling
- Lecture 7 - Concept of Similarity in Physical Modeling
- Lecture 8 - Dimensional analysis
- Lecture 9 - Physical Modeling of Isothermal and Non-Isothermal system
- Lecture 10 - Consideration in Aqueous Modeling
- Lecture 11 - Introduction to Stimulus Response Techniques
- Lecture 12 - Characterization of Flow
- Lecture 13 - Characterization of Flow in Actual Systems
- Lecture 14 - Analysis of RTD Curves
- Lecture 15 - Plug, Mixed and Dead Regions in Tundish
- Lecture 16 - Fluid Flow Fundamentals
- Lecture 17 - Mass Conservation Equation
- Lecture 18 - Momentum Conservation Equation
- Lecture 19 - Energy Conservation Equation
- Lecture 20 - Navier Stokes Equations for Newtonian Fluid
- Lecture 21 - Introduction to Turbulence in Fluid Flow
- Lecture 22 - Characteristics of Turbulent Flow
- Lecture 23 - RANS Equations
- Lecture 24 - Turbulent Flow Calculations
- Lecture 25 - Turbulence Modeling Using  $k-\epsilon$  Model
- Lecture 26 - Introduction to Heat Transfer Phenomena
- Lecture 27 - Numerical Methods for Solving Governing Equation
- Lecture 28 - Finite Volume Method for Convection and Diffusion Problems
- Lecture 29 - Different Discretization Schemes
- Lecture 30 - Assessment of Discretization Schemes
- Lecture 31 - Elements of Mathematical Modeling in Tundish Steelmaking

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[Lecture 33 - Flow Analysis in Tundish](#)

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[Lecture 38 - Modeling Consideration For Inclusion Removal in Tundish - II](#)

[Lecture 39 - Case Studies in Modeling of Tundish Steelmaking - 1](#)

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Lecture 1 - Introduction

Lecture 2 - Biomaterial

Lecture 3 - Biocompatibility

Lecture 4 - Host response

Lecture 5 - Tissue Eng

Lecture 6 - Scaffold

Lecture 7 - Bone structure

Lecture 8 - Bone properties

Lecture 9 - Implant - I

Lecture 10 - Implant - II

Lecture 11 - Proteins

Lecture 12 - Cell structure

Lecture 13 - Bacteria structure

Lecture 14 - Antibacterial assay

Lecture 15 - Cell fate processes

Lecture 16 - Cell division

Lecture 17 - Cell differentiation

Lecture 18 - Stem cells

Lecture 19 - Osseointegration

Lecture 20 - In vivo testing

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Lecture 26 - Clinical trials - I

Lecture 27 - Clinical trials - II

Lecture 28 - Metal manufacturing

Lecture 29 - Ceramics manufacturing

Lecture 30 - Polymers manufacturing

Lecture 31 - Additive manufacturing

[Lecture 32 - HA-Ti-Toughness, Cell functionality](#)

[Lecture 33 - HA-CaTiO<sub>3</sub> development](#)

[Lecture 34 - HA- BaTiO<sub>3</sub> Functional Prop](#)

[Lecture 35 - HA-Ag antimicrob and cell viability](#)

[Lecture 36 - HA-ZnO, Cell fate and antimicrobial](#)

[Lecture 37 - Dental ceramics processing](#)

[Lecture 38 - Sr-based glass Ceramics](#)

[Lecture 39 - Acetabular socket \(Compression mold\)](#)

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[Lecture 39 - Live Session](#)

Lecture 1 - Tribology: Introduction

Lecture 2 - Surfaces and contacts

Lecture 3 - Friction: Laws and mechanisms

Lecture 4 - Contact temperature

Lecture 5 - Lubrication

Lecture 6 - Wear mechanisms: Adhesive wear

Lecture 7 - Wear mechanisms: Abrasive wear

Lecture 8 - Wear mechanisms: Tribochemical wear and Oxidative wear

Lecture 9 - Wear mechanisms: Fatigue wear and Fretting wear

Lecture 10 - Wear mechanisms: Erosive wear

Lecture 11 - Overview of tribological materials

Lecture 12 - Friction and wear of metal matrix composites

Lecture 13 - Overview: Bioceramics and Biocomposites

Lecture 14 - Fabrication of engineering polymers

Lecture 15 - Polymer Ceramic Composites for Orthopedic Applications

Lecture 16 - Processing concepts of ceramics

Lecture 17 - Mechanical properties of ceramics

Lecture 18 - Fracture and toughening of brittle solids

Lecture 19 - Sliding wear of SiC Ceramics

Lecture 20 - Sliding wear of SiC-WC Composites

Lecture 21 - Friction and wear of HDPE-HA-Al<sub>2</sub>O<sub>3</sub>

Lecture 22 - Wear behavior of bioceramics and biocomposites

Lecture 23 - Tribological behavior of dental restorative materials

Lecture 24 - Wear of transformation toughened zirconia

Lecture 25 - Fretting wear of SiAlON Ceramics

Lecture 26 - Tribochemistry in wear of cermets

Lecture 27 - Overview: nanoceramic composites

Lecture 28 - Wear of YSZ nanoceramics

Lecture 29 - Wear behavior of nanostructured WC-ZrO<sub>2</sub> nanocomposites

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[Lecture 32 - Sliding wear of alumina ceramics and zirconia ceramics in cryogenic environment](#)

[Lecture 33 - Sliding wear of silicon carbide in cryogenic environment](#)

[Lecture 34 - Wear of TiB<sub>2</sub> Ceramic Composites](#)

[Lecture 35 - Erosive wear of ultra-high temperature NbB<sub>2</sub>-based ceramic composites](#)

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[Lecture 38 - Basics of ceramics coating techniques](#)

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Lecture 1 - Description of material properties

Lecture 2 - Direct and Coupled properties

Lecture 3 - Tensor algebra and property tensor

Lecture 4 - Tensor algebra (Continued...)

Lecture 5 - Property tensor: higher rank tensor and nonlinear property

Lecture 6 - Property tensor (Continued...)

Lecture 7 - Field tensor: Stress and strain

Lecture 8 - Point symmetry operation: rotation and inversion

Lecture 9 - Point symmetry operation: rotoinversion

Lecture 10 - Point symmetry operation: examples in material system

Lecture 11 - Crystal Systems, Bravais Lattices and Symmetry

Lecture 12 - Crystal Systems, Bravais Lattices and Symmetry

Lecture 13 - Crystal Systems, Bravais Lattices and Symmetry

Lecture 14 - Crystal Systems, Bravais Lattices and Symmetry

Lecture 15 - Crystal Systems, Bravais Lattices and Symmetry

Lecture 16 - Development of point group - Part 1

Lecture 17 - Development of point group - Part 2

Lecture 18 - Development of point group - Part 3 : Some visualization in real crystals

Lecture 19 - Point groups, polar groups and consequences in property

Lecture 20 - Structure-symmetry- property correlation

Lecture 21 - Ferroelectricity, polar point groups - I

Lecture 22 - Ferroelectricity, polar point groups - II

Lecture 23 - Space Groups - I

Lecture 24 - Space Groups - II

Lecture 25 - Visualizing Important Crystals (A space group perspective)

Lecture 26 - Some more popular structures and their visualization

Lecture 27 - Symmetry-property correlation - Part 1

Lecture 28 - Symmetry-property correlation - Part 2

Lecture 29 - Symmetry-property correlation - Part 3

Lecture 30 - Thermodynamics and equilibrium properties - Part 1

Lecture 31 - Thermodynamics and equilibrium properties - Part 2

- Lecture 32 - Thermodynamics and equilibrium properties - Part 3
- Lecture 33 - Thermodynamics and equilibrium properties - Part 4
- Lecture 34 - Statistical Mechanics
- Lecture 35 - Title Statistical Mechanics (Continued...)
- Lecture 36 - Properties as fluctuations and correlations of order parameter
- Lecture 37 - Properties as fluctuations and correlations (Continued...)
- Lecture 38 - Landau Theory and Phase Transitions
- Lecture 39 - Landau Theory and Phase Transitions (Continued...)
- Lecture 40 - Phase transitions and enhancement of fluctuations
- Lecture 41 - Dissipative properties
- Lecture 42 - Dissipative properties
- Lecture 43 - Dissipative properties: Onsagers linear response theory
- Lecture 44 - Onsagers linear response theory (Continued...)
- Lecture 45 - Onsagers theory: A few case studies
- Lecture 46 - Measurement of response function
- Lecture 47 - Small Signal Measurement
- Lecture 48 - Atomistic picture of Dielectric constant
- Lecture 49 - Relaxation vs Resonance
- Lecture 50 - Resonance
- Lecture 51 - Causality
- Lecture 52 - Kramers-Kronig relations
- Lecture 53 - Kramers-Kronig and Spectroscopy
- Lecture 54 - Spectroscopy at various time scale
- Lecture 55 - Spectroscopy (Continued...)
- Lecture 56 - Spectroscopy (Continued...)