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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](#)

[Lecture 33 - Concepts in Converting](#)

[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](#)

[Lecture 40 - Thoughts on Application of Energy Balance](#)

- 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

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[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](#)

[Lecture 40 - Organic Solar Cells and Organics Thin Film Transistors](#)

NPTEL : Steel Making (Metallurgy and Material Science)

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

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Lecture 3 - Geometry of Crystals: Symmetry, Lattices

Lecture 4 - Geometry of Crystals: Symmetry, Lattices

Lecture 5 - Geometry of Crystals: Symmetry, Lattices

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Lecture 7 - Geometry of Crystals: Symmetry, Lattices

Lecture 8 - Geometry of Crystals: Symmetry, Lattices

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Lecture 10 - Geometry of Crystals: Symmetry, Lattices

Lecture 11 - Geometry of Crystals: Symmetry, Lattices

Lecture 12 - Geometry of Crystals: Symmetry, Lattices (Continued...) and Miller Indices

Lecture 13 - Miller Indices

Lecture 14 - Miller Indices (Continued...) and Crystal Structures

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Lecture 17 - Crystal Structures

Lecture 18 - Crystal Structures

Lecture 19 - Crystal Structures

Lecture 20 - Crystal Structures

Lecture 21 - Crystal Structures (Continued...) and Defects in Crystals

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Lecture 23 - Defects in Crystals

Lecture 24 - Defects in Crystals

Lecture 25 - Defects in Crystals

Lecture 26 - Defects in Crystals

Lecture 27 - Defects in Crystals

Lecture 28 - Defects in Crystals

Lecture 29 - Defects in Crystals

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Lecture 31 - Diffusion in Solids

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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

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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

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Lecture 5 - Phase Rule-II and Single Component Equilibria

Lecture 6 - Single Component Phase Diagram

Lecture 7 - Binary Phase Diagram - Isomorphous Diagram

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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

Lecture 16 - Phase diagrams of binary peritectic System - II

Lecture 17 - Phase diagrams of binary peritectic System with intermediate phases

Lecture 18 - Intermediate Phases

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

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- 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
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- Lecture 42 - Phase Diagram of Ceramic
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- Lecture 44 - Ternary Phase Diagram - II
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- 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
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- Lecture 53 - Three Phase Equilibria
- Lecture 54 - Ternary Four Phase Equilibria - I
- Lecture 55 - Ternary Four Phase Equilibria - II
- 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 3 - Solidification (Welding)

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

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Lecture 27 - Introduction to Powder Processing (Continued...)

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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

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Lecture 10 - Nucleation Treatment Single Component (Solid-Liquid) - II

Lecture 11 - Solved Problem on Nucleation rate and How to determine the value of γ_{sl} Physical Concept & Interfacial Energy

Lecture 12 - How to determine the value of γ_{sl} (Physical Concept and Interfacial Energy)

Lecture 13 - Interfacial Energy - I

Lecture 14 - Interfacial Energy - II

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Lecture 16 - Heterogeneous Nucleation - II

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Lecture 26 - Critical Undercooling

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Lecture 29 - Nucleation kinetics in solid state

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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

Lecture 10 - Effect of Temperature

Lecture 11 - Cold, Warm and Hot Working

Lecture 12 - Mechanics of Metal Working

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Lecture 14 - Wire Drawing (Continued...)

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Lecture 19 - Types of Friction

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Lecture 11 - Miller Indices - Part 2

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- Lecture 14 - Principles of radical chain polymerization (Continued...)
- Lecture 15 - Principles of radical chain polymerization (Continued...)
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- Lecture 22 - Design of Chemical Reactors
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[Lecture 34 - Synthesis of industrial polymers \(Continued...\)](#)

[Lecture 35 - Synthesis of industrial polymers \(Continued...\)](#)

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[Lecture 37 - Synthesis of industrial polymers \(Continued...\)](#)

[Lecture 38 - Synthesis of industrial polymers \(Continued...\)](#)

[Lecture 39 - Synthesis of industrial polymers \(Continued...\)](#)

[Lecture 40 - Synthesis of industrial polymers \(Continued...\)](#)

[Lecture 41 - Synthesis of industrial polymers \(Continued...\)](#)

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[Lecture 44 - Synthesis of industrial polymers \(Continued...\)](#)

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[Lecture 6 - Bulk Metallic Glass, Glassy and Amorphous Materials](#)

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[Lecture 58 - Advanced Functional Alloys \(Continued...\)](#)

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- 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
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- 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

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Lecture 38 - Electro and Electroless Deposition Process

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Lecture 40 - Hot Dipping - II

Lecture 41 - Thermal Spray Deposition - I

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Lecture 48 - Composite Coating

Lecture 49 - Ion Implantation - I

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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

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Lecture 2 - Various Routes of steelmaking

Lecture 3 - The Iron Blast Furnace

Lecture 4 - Thermodynamics of BF ironmaking

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Lecture 6 - Overall Heat and Material Balance in Blast Furnace

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

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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 its 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

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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
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- 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

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- [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](#)
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- [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
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- Lecture 40 - Imaging in SEM (Continued...)
- Lecture 41 - Imaging in SEM and X-ray diffraction
- Lecture 42 - Continuous and characteristics X-ray spectrum
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- Lecture 46 - X-ray absorption and filters
- Lecture 47 - Intensity of diffracted beam
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- 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 - O₂ batteries
- Lecture 42 - Electrolytes for Li - O₂ 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 - Macrotecture 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

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- 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
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- Lecture 11 - Friction and Wear-Part - I
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- Lecture 16 - Failure Analysis - Part I
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- Lecture 22 - Prevention of Chemical/Electrochemical Degradation
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- Lecture 25 - Prevention of Mechanical Degradation
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- Lecture 27 - Mechanical and Electrochemical Testing - Part I
- Lecture 28 - Mechanical and Electrochemical Testing - Part II
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- Lecture 30 - Characterization
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- Lecture 32 - Scope, Classification and Objectives of Surface Engineering
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- Lecture 41 - Diffusion Based Coatings - Solid State
- Lecture 42 - Chemical Conversion Coatings
- Lecture 43 - Electrodeposition
- Lecture 44 - Electrophoretic and Electroless deposition
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- Lecture 46 - Thick Coatings by Weld Overlay and Cladding
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- 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
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- 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
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Lecture 2 - Theoretical Strengths and Defects

Lecture 3 - Stress Concentration

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Lecture 5 - Griffith Criteria - Modification

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Lecture 7 - Fracture Toughness and Plane Stress-Plane Strain

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Lecture 11 - Plane Strain Fracture Toughness Testing

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Lecture 4 - Mine Closure Costs and Financing Approaches

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Lecture 6 - Demolition Techniques

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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

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Lecture 12 - Tools and Techniques for Closure Plan Development and Procedures

Lecture 13 - Closure Plan Development Procedures

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Lecture 21 - Application of Remote Sensing for Mine Closure-Introduction

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Lecture 33 - Principle of Asset Management and Decommissioning of Assets for Site Restoration

Lecture 34 - Brownfield Redevelopment and Value Addition to Assets

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Lecture 38 - Sustainability Measurement and Reporting (Continued...)

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Lecture 58 - Best mining practices for Sustainable mining - Case studies

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- 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
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- Lecture 6 - Hybrid materials - Composite
- Lecture 7 - Cellular solids - Applications of metal foams
- Lecture 8 - Cellular solids - Applications of porous ceramics and polymer foams
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- Lecture 10 - Composite Classification - Matrix and Reinforcement
- Lecture 11 - Fibers - Fundamentals, Glass fiber
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- 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
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- Lecture 23 - Processing of metal foams - Foaming techniques
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- 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
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- Lecture 45 - Deformation behavior of honeycomb and foams
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- Lecture 48 - Deformation behaviour of Foams (Continued...)
- Lecture 49 - Thermal properties of foams
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- Lecture 51 - Advanced composites - MMCs
- Lecture 52 - Advanced composites - MMCs (Continued...)
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- 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
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- Lecture 60 - Advanced hybrid material - Functionally graded composite materials (FGMs) (Continued...)

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Lecture 36 - Copper Extraction: Flash Smelting

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Lecture 42 - Reduction Smelting: Zinc Extraction and ISP

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

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Lecture 45 - Silicothermy: Pyrometallurgical Magnesium Extraction

Lecture 46 - Reduction Smelting: Iron Extraction in Blast Furnace

Lecture 47 - Alternative Routes of Iron Extraction

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Lecture 50 - Chemical Refining: Purification of Lead

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

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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

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Lecture 6 - Coal Cleaning

Lecture 7 - Coal Cleaning (Continued...)

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Lecture 9 - Coal Cleaning (Continued...)

Lecture 10 - Coal Cleaning (Continued...)

Lecture 11 - Coal Cleaning Methods

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Lecture 13 - Coal Cleaning Methods (Continued...)

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Lecture 15 - Coal Cleaning Methods (Continued...)

Lecture 16 - Coal Combustion Fundamentals

Lecture 17 - Coal Combustion Fundamentals (Continued...)

Lecture 18 - Coal Combustion Fundamentals (Continued...)

Lecture 19 - Coal Combustion Fundamentals (Continued...)

Lecture 20 - Coal Combustion Fundamentals (Continued...)

Lecture 21 - Effects of Coal Properties on Combustion

Lecture 22 - Effects of Coal Properties on Combustion (Continued...)

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Lecture 24 - Effects of Coal Properties on Combustion (Continued...)

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Lecture 26 - Industrial Coal Combustion Methods

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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

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Lecture 15 - Errors in drawing phase diagrams, Fe-C vs. Fe-Fe₃C phase diagram

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Lecture 19 - Precipitation - quasicrystals

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Lecture 21 - Spinodal decomposition

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Lecture 29 - Phase diagram calculations

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

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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

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Lecture 8 - Differential interference contrast and fluorescence microscopy

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Lecture 10 - Tutorial problems

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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

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

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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

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- 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
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- Lecture 38 - TEM imaging-1
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- Lecture 41 - TEM sample preparation-1
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- Lecture 43 - XRD Tutorial - 1
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- Lecture 47 - Quantitative metallography - Tutorial 1
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Lecture 3 - Thermal Expansion

Lecture 4 - Measuring Electrical Conductivity: DC and AC

Lecture 5 - Free Electron Gas

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

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- Lecture 13 - Superplasticity and the Nanoscale: Experimental aspects
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- 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...)

- Lecture 1 - Introduction to Manufacturing science
- Lecture 2 - Finite difference method and Finite volume method
- Lecture 3 - Introduction to Finite Element Methods
- Lecture 4 - Introduction to Finite Element Methods
- Lecture 5 - Introduction to Boundary element methods
- Lecture 6 - Introduction to casting and solidification
- Lecture 7 - Solidification of metal and alloys
- Lecture 8 - Introduction to casting
- Lecture 9 - Introduction to casting
- Lecture 10 - Introduction to casting
- Lecture 11 - Introduction to casting and its types
- Lecture 12 - Types of casting and defects
- Lecture 13 - Introduction to die filling analysis
- Lecture 14 - Porosity Modelling and Gravity die casting
- Lecture 15 - Rheology
- Lecture 16 - Case studies on Die filling
- Lecture 17 - Introduction to welding
- Lecture 18 - Principle of fusion welding
- Lecture 19 - Principle of fusion welding
- Lecture 20 - Welding Mechanics
- Lecture 21 - Welding Mechanics, Types of welding
- Lecture 22 - Types of welding
- Lecture 23 - Types of welding
- Lecture 24 - Types of welding
- Lecture 25 - Types of welding
- Lecture 26 - Procedure for numerical modelling
- Lecture 27 - Procedure for solving governing equations
- Lecture 28 - Procedure for solving governing equations
- Lecture 29 - Solvers and Boundary conditions
- Lecture 30 - Transport phenomena during solidification (Continued...)
- Lecture 31 - Introduction to Powder Metallurgy

- Lecture 32 - Process methodology on Powder Metallurgy
- Lecture 33 - Process methodology on Powder Metallurgy
- Lecture 34 - Atomization and Sintering
- Lecture 35 - Theory of sintering
- Lecture 36 - Theory of sintering
- Lecture 37 - Different processes in powder metallurgy
- Lecture 38 - Design of the molding system
- Lecture 39 - Ceramic Injection Molding and metal injection molding
- Lecture 40 - Metal forming and process modelling
- Lecture 41 - Mechanics of metal working
- Lecture 42 - Mechanics of metal working
- Lecture 43 - Metal working processes
- Lecture 44 - Metal working processes
- Lecture 45 - Metal working processes
- Lecture 46 - Metal working processes
- Lecture 47 - Phase field Modelling
- Lecture 48 - Numerical Modelling for welding
- Lecture 49 - Introduction to Additive manufacturing
- Lecture 50 - Numerical Modelling of Additive manufacturing
- Lecture 51 - Phase field
- Lecture 52 - Transport phenomena, Process modelling of Metal forming, Machining

Lecture 1 - Introduction to additive manufacturing

Lecture 2 - Introduction and classification of AM processes

Lecture 3 - Advantages of AM over Conventional Manufacturing

Lecture 4 - Design aspects in 3D printing

Lecture 5 - Introduction to Engineering Materials

Lecture 6 - Properties of material classes

Lecture 7 - Introduction to material characterization

Lecture 8 - Introduction to mechanical property of materials

Lecture 9 - Overview of AM Processes and Demonstration of industry-scale L-PBF machine

Lecture 10 - Overview of AM Processes

Lecture 11 - Binderjet 3D printing: Process Science

Lecture 12 - Scientific Case study: Binderjet 3D printing of Ti6Al4V

Lecture 13 - Scientific Case study: Binderjet 3D printing of Ti-6Al-4V with in situ polymerisable ink

Lecture 14 - Scientific Case study: Binderjet 3D printing of Ti-6Al-4V with in situ polymerisable ink

Lecture 15 - Scientific Case study: Zirconia based bioceramics: binderjet printing using the novel binder

Lecture 16 - Scientific Case study: Binderjet 3D Printing of bioceramics

Lecture 17 - Inkjet Cell Printing

Lecture 18 - Process Science of Laser-based AM Process of metallic materials

Lecture 19 - Microstructure development during Laser-based AM Process

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Lecture 21 - Introduction to Cellular structure and Topology Optimisation

Lecture 22 - Scientific case study: SLM Printing of Ti6Al4V lattice structures and properties

Lecture 23 - Scientific case study: SLM Printing of SS316L lattice structures and properties

Lecture 24 - Labscale Demonstration of Directed Energy Deposition (DED)-printing of Materials

Lecture 25 - Additive Manufacturing of Materials - Applications, solutions and Future Perspective

Lecture 26 - Additive Manufacturing of Materials - Applications, solutions and Future Perspective

Lecture 27 - Introduction to biological system

Lecture 28 - Introduction to biological system

Lecture 29 - Introduction to Biological System

Lecture 30 - Introduction to biological system

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

Lecture 31 - Fundamentals of Rheology

Lecture 32 - Process Science: 3D extrusion (Bio)printing/4D Bioprinting

Lecture 33 - Process Science: 3D extrusion (Bio)printing/4D Bioprinting

Lecture 34 - Scientific case study: 3D extrusion printing of Alginate-Gelatin hydrogels

Lecture 35 - 3D extrusion printing of Gelatin glycidyl methacrylate/alginate/nanocellulose-based hydrogel

Lecture 36 - Scientific case study-3D extrusion bioprinting of GelMA hydrogels for hard tissue

Lecture 37 - 3D extrusion (Bio)printing of GelMA hydrogels for hard tissue

Lecture 38 - 3D (Bio)printing of GelMA hydrogels for neural tissue regeneration

Lecture 39 - 3D (Bio)printing of GelMA hydrogels for neural tissue regeneration

Lecture 40 - Lab-scale demonstration of 3D extrusion printing of hydrogels

Lecture 41 - 3D printing of cranium models mediated bone flaps for patient-specific Cranioplasty surgery

Lecture 42 - 3D printing of cranium models mediated bone flaps for patient-specific Cranioplasty surgery

Lecture 43 - 3D printing of Ceramic Dental implants

Lecture 44 - 3D printing of Ceramic Dental implants

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Lecture 46 - Emerging topics in AM - Introduction to artificial intelligence and machine learning

Lecture 47 - Emerging topics in AM - Introduction to artificial intelligence and machine learning

Lecture 48 - Scientific case study - DED of SS316L melt pool prediction using machine learning

Lecture 49 - Scientific case study - AI/ML for regression and Classification analysis in DED 3D printing

Lecture 50 - Challenges and opportunities in Additive Manufacturing

Lecture 51 - Challenges and opportunities in Additive Manufacturing

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Lecture 56 - Challenges and opportunities in Additive Manufacturing

Lecture 57 - Emerging opportunity: Bioprinting in Space

Lecture 58 - Emerging opportunity: Bioprinting in Space

Lecture 59 - Summary of key concepts in AM

Lecture 60 - Summary of Emerging topics and challenges in AM