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[Lecture 67 - Compressed and Liquid Hydrogen Related Hazards](#)

[Lecture 68 - Regulations, Codes and Standards](#)

[Lecture 69 - Utilisation in Different Sectors, Global Status and Future Directions](#)

Lecture 1 - Stirling's Approximation

Lecture 2 - Fourier Transforms and characteristic function

Lecture 3 - Dirac Delta function

Lecture 4 - Applications of delta function and Generating functions

Lecture 5 - Laplace Transforms and Convolution theorem

Lecture 6 - Generating function for discrete variables and Binomial distribution

Lecture 7 - Bernoulli and Poisson distributions

Lecture 8 - Waiting time distributions; Gaussian approximation to Poisson distribution

Lecture 9 - Introduction to Central Limit Theorem

Lecture 10 - Proof of Central Limit Theorem (CLT)

Lecture 11 - Universality of Normal distribution and Exceptions

Lecture 12 - Introduction to Random Walk: Extension of Central Limit Theorem

Lecture 13 - Random walk and Diffusion coefficient: Conditional and Transition

Lecture 14 - Characteristics of Stochastic Phenomena: Markov Processes

Lecture 15 - Propagating Markov processes via Transition Probability Matrix with

Lecture 16 - Chapman-Kolmogorov Equation for Multistep Transition probability and solution

Lecture 17 - Transient solutions and Continuous time Markov process

Lecture 18 - Exact solution to Symmetric (or unbiased) one-dimensional Random walk (1-D RW)

Lecture 19 - Properties of the solution for 1-D unbiased RW

Lecture 20 - 1-D unbiased RW: Asymptotic form of occupancy probability and transition

Lecture 21 - Solution to the problem of 1-D Random Walk with Bias

Lecture 22 - Generalized Random Walk with Bias and Pausing

Lecture 23 - Effect of Pausing on Mean and Variance of Random walk

Lecture 24 - Random-walk in the presence of reflecting barrier

Lecture 25 - Boundary conditions for reflected Random-Walk and formulating absorbing

Lecture 26 - The survival probability and first-passage time distribution for Random walker

Lecture 27 - Random Walk with Bias and Absorber

Lecture 28 - Drift and Survival probability for Random walk with bias and absorber

Lecture 29 - Introduction to gambler's ruin problem

Lecture 30 - Solution for ultimate winning probability in Gambler's ruin problem

Lecture 31 - Solution to gambler's ruin problem with site dependent jump probabilities

- Lecture 32 - Fourier transform method of solving lattice Random walks
- Lecture 33 - Two and higher dimensional Random walks
- Lecture 34 - Formulating the problem of Probability of Return to the origin
- Lecture 35 - Relationship between occupancy probability and first-time-return probability
- Lecture 36 - Proof of Polya's theorem on the probability of return
- Lecture 37 - Return probability estimates in various dimensions and effect of bias in 1-D
- Lecture 38 - Dependence of first time return probability ( $F_k$ ) on steps
- Lecture 39 - Equilibrium solutions in lattice random walk models
- Lecture 40 - Equilibrium solution to Ehrenfest's flea model
- Lecture 41 - Differential equation formulation of stochastic phenomena
- Lecture 42 - Derivation of Fokker-Planck equation
- Lecture 43 - Generalized transition probability functions for Fokker-Planck equation
- Lecture 44 - Solution to 1-D Fokker-Planck equation for free particle: Method of Fourier
- Lecture 45 - General non-gaussian solution to translationally invariant Chapman-Kolmogorov
- Lecture 46 - Cauchy distribution, power-law and other non-gaussian solutions
- Lecture 47 - Wiener process and solution to absorbing barrier problems from Fokker-Planck
- Lecture 48 - Application of Fourier Sine transform for single absorber problem
- Lecture 49 - Setting up Langevin equation for velocity fluctuations of Brownian particles
- Lecture 50 - Understanding the origin of systematic and random parts of force from kinetic
- Lecture 51 - Kinetic derivation of a formula for delta-correlated random force
- Lecture 52 - Mean square velocity, thermal equilibrium and relationship between relaxation
- Lecture 53 - Velocity autocorrelation in Brownian motion
- Lecture 54 - Derivation of Stokes-Einstein relationship between diffusion coefficient and
- Lecture 55 - Alternative derivation of Stokes-Einstein relationship and Brownian motion with
- Lecture 56 - Numerical simulation of the Langevin equation
- Lecture 57 - Derivation of Klein-Kramers equation from Langevin equation for joint
- Lecture 58 - Illustrative solutions to the Klein-Kramers equation
- Lecture 59 - Numerical simulation: Sampling from general distributions and Central
- Lecture 60 - Numerical simulation of Random walk trajectories and method of solving Fokker

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**NPTEL : Interfacial Engineering (Chemical Engineering)**

**Co-ordinators : Prof. A.N. Bhaskarwar**

Lecture 1 - General Introduction Definitions

Lecture 2 - General Introduction, Definitions, Surface Tension

Lecture 3 - Surface Tension Free Energies and Adsorption

Lecture 4 - Properties over Curved Surfaces

Lecture 5 - Total Surface Energy

Lecture 6 - Interfacial Tension Entropy, Cohesion, Adhesion

Lecture 7 - Cohesion, Adhesion and Spreading

Lecture 8 - Spreading from Liquids and Solids

Lecture 9 - Spreading, Interfacial Tensions, Surface Tensions

Lecture 10 - Spreading, Contact Angles Free Energies

Lecture 11 - Spreading/Contact Angles Rough Surfaces, Free Energies

Lecture 12 - Spreading/Contact Angles Work of Adhesion, De-wetting

Lecture 13 - Work of Adhesion, Surface and Interfacial Tensions

Lecture 14 - Surface and Interfacial Tensions: Drop Weight and Wilhelmy Plate Methods

Lecture 15 - Surface and Interfacial Tensions: Wilhelmy Plate, Pendant Drop and Maximum Bubble Pressure Methods

Lecture 16 - Wetting Balance Method Spreading Coefficient Work of Adhesion Sessile Drop Method, Positive S

Lecture 17 - Indirect and Direct Methods for Positive S, Adhesion Energies Interfacial Potentials

Lecture 18 - Surface and Interfacial Potentials Distribution and Contact Potentials

Lecture 19 - Diffusion Potential Surface and Interfacial Potentials Components of Contact Potential

Lecture 20 - Electrically Charged Monolayers Gouy Theory

Lecture 21 - Equations of State, Cohesion Repulsion, Limiting Area

Lecture 22 - Condensed and Liquid Expanded Monolayers Phase Transformations

Lecture 23 - Films of Polymers Molecular Weight, Surface Viscosity Drag, Canal Method

Lecture 24 - Canal Method Joly's Semi-Empirical Correction Rotational Torsional Surface Viscometer Compressional Moduli

Lecture 25 - Magnitudes of Surface Compressional Moduli Surface Waves and Ripples

Lecture 26 - Surface waves and Ripples, Velocity Effect of Surface Tension and Surface Compressional Modulus Rates of adsorption and absorption Damping

Lecture 27 - Surface waves and ripples, velocity effect of surface tension and surface compressional modulus damping for clean and contaminated, surfaces, fiber from monolayers

Lecture 28 - Shear Elastic Moduli, Yield Stress Fibres from MLs, Surface Reactions

Lecture 29 - Surface Reactions, Comparison with Bulk-Phase Reactions Steric Factors, Inhibition

Lecture 30 - Hydrolyses of Esters by Alkali Acid or Enzyme Photochemical Reactions in Monolayers Polymerization in MLs,

Lactonization

Lecture 31 - Catalytic Effects Reactions in Emulsions Complex Formation

Lecture 32 - Complex Formation Penetration into Monolayers Thermodynamics of Penetration Adsorption from Vapour Phase Mass Transfer

Lecture 33 - Introductory Concepts Resistances and their Magnitudes Evaporation and its Retardation

Lecture 34 - Evaporation and its Retardation Resistances and their Analysis Diffusional Resistance in Gas Phase

Lecture 35 - Resistances in Liquid Phase and Interface and Their Importance Some Effects and Applications, Theory

Lecture 36 - Surface Instability Theories of Mass Transfer Experiments on static and Dynamic Systems

Lecture 37 - Colloids, Aerosols, Emulsions Foams, Coagulation Smoluchowski's Theory

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[Lecture 5 \(3\)](#)

[Lecture 6 \(3A\)](#)

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[Lecture 64 \(31\)](#)



Lecture 1 - Flowsheet Synthesis - I

Lecture 2 - Flowsheet Synthesis - II

Lecture 3 - Mass Balance - I

Lecture 4 - Mass Balance - II

Lecture 5 - Mass and Energy Balance of Complete Flowsheet

Lecture 6 - Equipment Sizing and Costing

Lecture 7 - Economic Evaluation

Lecture 8 - Design of Batch Plants

Lecture 9 - Simulations for Process Flowsheet

Lecture 10 - Optimization Methods used for Designing

Lecture 11 - Heat Exchanger Network Design - 1

Lecture 12 - Heat Exchanger Network Design - 2

Lecture 13 - Geometric Methods for Reactor Network Synthesis

Lecture 14 - Optimization Methods for Process Design - 1

Lecture 15 - Optimization Methods for Process Design - 2

Lecture 16 - Quantifying Sustainability for Design

Lecture 17 - Process Network Analysis and Footprint Assessment

Lecture 18 - Energy, Exergy and Emergy

Lecture 19 - Ecosystems in Sustainability Assessment

**NPTEL : Heat Transfer (Chemical Engineering)**

**Co-ordinators : Prof. A.K. Ghoshal**

- Lecture 1 - Introduction to heat transfer
- Lecture 2 - General heat conduction equation
- Lecture 3 - One dimensional steady state conduction in rectangular coordinate
- Lecture 4 - One dimensional steady state conduction in cylindrical and spherical coordinate
- Lecture 5 - Critical and optimum insulation
- Lecture 6 - Extended surface heat transfer - 1
- Lecture 7 - Extended surface heat transfer - 2
- Lecture 8 - Analysis of lumped parameter model
- Lecture 9 - Transient heat flow in semi infinite solid
- Lecture 10 - Infinite body subjected to sudden convective
- Lecture 11 - Graphical solutions of unsteady state heat conduction problem
- Lecture 12 - Dimensional analysis for forced convection
- Lecture 13 - Dimensional analysis for free convection
- Lecture 14 - Heat transfer co-relations for laminar and internal flows
- Lecture 15 - Heat transfer co-relations for turbulent and internal flows
- Lecture 16 - Co-relation for turbulent and external flows
- Lecture 17 - Heat transfer co-relations for flow across tube banks
- Lecture 18 - Momentum and heat transfer analogies
- Lecture 19 - Boundary layer heat transfer
- Lecture 20 - Boundary layer equations
- Lecture 21 - Approximate analysis in boundary layer
- Lecture 22 - Theoretical concepts of natural / free convection heat transfer
- Lecture 23 - Empirical relations for free convection heat transfer
- Lecture 24 - Condensation heat transfer over vertical plate
- Lecture 25 - Condensation heat transfer for various conditions and geometries
- Lecture 26 - Fundamentals of boiling heat transfer
- Lecture 27 - Boiling heat transfer co-relations
- Lecture 28 - Classification of heat exchangers
- Lecture 29 - Various types of shell and tube heat exchangers
- Lecture 30 - Various types of compact heat exchangers
- Lecture 31 - Effectiveness-NTU, method of heat exchanger analysis

[Lecture 32 - Design of double pipe heat exchanger](#)

[Lecture 33 - Design of shell and tube heat exchanger](#)

[Lecture 34 - Introduction to evaporation and evaporators](#)

[Lecture 35 - Evaporation principles and evaporator performance](#)

[Lecture 36 - Evaporator calculations](#)

[Lecture 37 - Introduction to radiation heat transfer](#)

[Lecture 38 - Radiation intensity and radiation view factor](#)

[Lecture 39 - Radiation heat exchange](#)

[Lecture 40 - Radiation shield and gas radiation](#)



**NPTEL : Mass Transfer Operations I (Chemical Engineering)**

**Co-ordinators : Dr. B. Mandal**

- Lecture 1 - Introduction to Mass Transfer
- Lecture 2 - Molecular Diffusion
- Lecture 3 - Fick's Law of Diffusion
- Lecture 4 - Steady state molecular diffusion in fluids - Part I
- Lecture 5 - Steady state molecular diffusion in fluids - Part II
- Lecture 6 - Diffusion coefficient: Measurement and Prediction - Part I
- Lecture 7 - Diffusion Coefficient: Measurement and Prediction - Part II
- Lecture 8 - Multicomponent Diffusion and Diffusivity in Solids
- Lecture 9 - Concept of Mass Transfer Coefficient
- Lecture 10 - Dimensionless Groups and Co-relations for Convective
- Lecture 11 - Mass Transfer co-efficient in Laminar Flow Condition
- Lecture 12 - Boundary Layer Theory and Film Theory in Mass Transfer
- Lecture 13 - Mass Transfer Coefficients in Turbulent Flow
- Lecture 14 - Interphase Mass Transfer and Mass Transfer Theories - Part I
- Lecture 15 - Interphase Mass Transfer and Mass Transfer Theories - Part II
- Lecture 16 - Interphase Mass Transfer and Mass Transfer Theories - Part III
- Lecture 17 - Agitated and Sparged Vessels
- Lecture 18 - Tray Column - Part I
- Lecture 19 - Tray Column - Part II
- Lecture 20 - Packed Tower
- Lecture 21 - Introduction to Absorption and Solvent selection
- Lecture 22 - Packed Tower Design - Part I
- Lecture 23 - Packed Tower Design - Part II
- Lecture 24 - Packed Tower Design - Part III
- Lecture 25 - Mass Transfer Coefficients Correlation and HETP Concept
- Lecture 26 - Tray Tower Design and Introduction to Multicomponent System
- Lecture 27 - Introduction to Distillation and Phase diagrams
- Lecture 28 - Azeotropes and Enthalpy Concentration Diagrams
- Lecture 29 - Flash Distillation
- Lecture 30 - Batch and Steam Distillation
- Lecture 31 - Fractional Distillation

[Lecture 32 - Fractional Distillation: McCabe Thiele Method](#)

[Lecture 33 - Fractional Distillation: Minimum Reflux and Pinch Point](#)

[Lecture 34 - Fractional Distillation: Subcooled Reflux ,Tray Efficiency and Use of Open Steam](#)

[Lecture 35 - Fractional Distillation: Multiple Feeds and Side Stream](#)

[Lecture 36 - Multistage Batch Distillation with Reflux](#)

[Lecture 37 - Fractional Distillation: Ponchan and Savarit Method](#)

[Lecture 38 - Ponchan and Savarit Method and Packed Tower Distillation](#)

[Lecture 39 - Multicomponent Distillation](#)

Lecture 1 - General Introduction to the Course and Syllabus

Lecture 2 - Hierarchical Approach to Process Design - I

Lecture 3 - Hierarchical Approach to Process Design - Examples

Lecture 4 - Input Information and Design Aspects of Batch vs. Continuous Process

Lecture 5 - Input / Output Structure of Flowsheet - Part I

Lecture 6 - Input / Output Structure of Flowsheet - Part II

Lecture 7 - Input / Output Structure of Flowsheet - Part III and Recycle Structure of Flowsheet - Part I

Lecture 8 - Recycle Structure of Flowsheet - Part II

Lecture 9 - Recycle Structure of Flowsheet - Part III

Lecture 10 - Recycle Structure of Flowsheet - Part IV and Tutorial - Part I

Lecture 11 - Tutorial - Part II

Lecture 12 - Tutorial - Part III

Lecture 13 - Algorithm and Basic Principles of Reactor Design

Lecture 14 - Reactor Non-ideality, Residence Time Distribution (RTD) and Types of Chemical Reactions & Catalysts

Lecture 15 - Types of Reactors and Selection Criteria

Lecture 16 - Tutorial on Reactor Design and Cost Estimation

Lecture 17 - General Introduction (Types of Separation Processes and Criteria for Selection of the Processes)

Lecture 18 - Guidelines for Design of Separation Systems

Lecture 19 - Design of Distillation Columns - Part I (Sequencing of Columns, Energy Integration / Thermal Coupling of the Columns)

Lecture 20 - Design of Distillation Columns - Part II (Plate and Packed Towers, Number of Plates, Diameter and Height of the Column)

Lecture 21 - Tutorial - Part I (Design of Absorption Column)

Lecture 22 - Tutorial - Part II (Design of Distillation Column)

Lecture 23 - Concepts and Basic Principles of Energy (or Heat) Integration - Part 1 (Composite Curves and  $T_{min}$ )

Lecture 24 - Concepts and Basic Principles of Heat Integration - Part 2 (Problem Table Algorithm and Identification of Energy Targets)

Lecture 25 - Identification of Area and Cost Targets

Lecture 26 - Pinch Technology for Heat Exchanger Network Design

Lecture 27 - Tutorial - I (Composite Curves, Problem Table Algorithm and Enthalpy Intervals)

Lecture 28 - Tutorial - II (Heat Exchanger Network Synthesis Using Pinch Technology)

Lecture 29 - Selection of Process, Design of Flowsheet and Materials Balance

Lecture 30 - Energy Balance, Process Alternatives and Design of the Absorber

Lecture 31 - Rules of Thumb & Their Limitations and Tutorial

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[Lecture 32 - General Concepts & Principles and Cost Allocation Procedure](#)

[Lecture 33 - Lumped Cost Diagram and Cost Allocation Diagram \(Case Study of Hydro-dealkylation Process\)](#)

[Lecture 34 - Assessment of Process Alternatives with Cost Allocation Diagram \(Case Study of Hydrodealkylation Process\)](#)

[Lecture 35 - Tutorial on Lumped Cost Diagram and Cost Allocation Diagram](#)

[Lecture 36 - Introduction to Chemical Projects and Their Economic Aspects](#)

[Lecture 37 - Selection of the Process and Project Site - Part I](#)

[Lecture 38 - Selection of the Process and Project Site - Part II](#)

[Lecture 39 - Project Cost Estimation - Part I](#)

[Lecture 40 - Project Cost Estimation - Part II](#)

[Lecture 41 - Simplified Cost Model and Depreciation](#)

[Lecture 42 - Time Value of Money](#)

[Lecture 43 - Measures of Profitability and Project Evaluation - Part I](#)

[Lecture 44 - Measures of Profitability and Project Evaluation - Part II](#)

[Lecture 45 - Tutorial on Project Economics - Part I](#)

[Lecture 46 - Tutorial on Project Economics - Part II](#)

Lecture 1 - Introduction

Lecture 2 - Particle properties

Lecture 3 - Particle / Powder Classifications

Lecture 4 - Minimum Fluidization Velocity: Fluid-solid System

Lecture 5 - Minimum Fluidization Velocity: Liquid-solid and gas-liquid-solid System

Lecture 6 - Flow regime and its map: Gas-solid Fluidization

Lecture 7 - Flow regime and its map: Liquid-solid and Gas-liquid-solid Fluidization

Lecture 8 - Frictional pressure drop in fluidized bed-fluid-solid system

Lecture 9 - Frictional pressure drop in fluidized Bed-Gas-liquid-solid system

Lecture 10 - Analysis of Frictional Pressure Drop in Fluidized Bed By Different Models

Lecture 11 - Gas Distribution Through Distributor

Lecture 12 - Calculation of gas pumping power consumption in fluidized bed

Lecture 13 - Bubbling Fluidization Part 1: Bubble Characteristics

Lecture 14 - Bubbling Fluidization Part 2: Bubble Characteristics (Continued...)

Lecture 15 - Bubbling Fluidization Part 3: Bubble coalescence in three-phase fluidization

Lecture 16 - Bubbling Fluidization Part 4: Bubble breakup in three-phase fluidization

Lecture 17 - Bubbling Fluidization Part 5: Gas and solid movements at bubble

Lecture 18 - Bubbling Fluidization Part 6: Slugging Bed

Lecture 19 - Entrainment Characteristics (Part 1) : Entrainment Characteristics

Lecture 20 - Entrainment Characteristics (Part 2) : Fast fluidization condition

Lecture 21 - Entrainment Characteristics (Part 2) : Elutriation Characteristics

Lecture 22 - Entrainment Characteristics (Part 2) : Attrition in Fluidized Bed (Part 1)

Lecture 23 - Attrition in Fluidized Bed (Part 2)

Lecture 24 - Solid movement, mixing: Gas-fluidized Bed

Lecture 25 - Solid segregation: Gas-fluidized bed

Lecture 26 - Solid mixing and segregation: Liquid-solid fluidized bed

Lecture 27 - Gas Dispersion and Interchange

Lecture 28 - Mass transfer in fluidized Bed-Gas-solid system

Lecture 29 - Mass transfer in fluidized Bed-Gas-liquid-solid system (Continued...)

Lecture 30 - Heat transfer Characteristics

Lecture 31 - Fluidized bed reactor design and its performance



[Lecture 1 - An Introduction](#)

[Lecture 2 - Fluid Mechanics: A Review](#)

[Lecture 3 - Solid Mechanics: A Review](#)

[Lecture 4 - Rheology of blood](#)

[Lecture 5 - Blood morphology](#)

[Lecture 6 - Blood flow in a channel](#)

[Lecture 7 - Viscometers and Rheometers](#)

[Lecture 8 - Viscoelasticity](#)

[Lecture 9 - Flow Bifurcation](#)

[Lecture 10 - Pulsatile Flow 1](#)

[Lecture 11 - Pulsatile Flow 2](#)

[Lecture 12 - Flow in Elastic Tubes](#)

Lecture 1 - An Introduction

Lecture 2 - Interface and Surface Tension

Lecture 3 - Flow Regimes 1

Lecture 4 - Flow Regimes 2

Lecture 5 - Taylor Flow 1

Lecture 6 - Taylor Flow 2

Lecture 7 - Computational Techniques

Lecture 8 - Bubble and Droplet Generation

Lecture 9 - Interface and Surface tension 2

Lecture 10 - Void Fraction and Pressure Drop

Lecture 11 - Liquid-Liquid Flow: Flow Regimes

Lecture 12 - Ideal annular Flow

Lecture 13 - Taylor Flow : Heat transfer 1

Lecture 14 - Taylor Flow : Heat transfer 2

Lecture 15 - Taylor Flow : Meat Transfer 1

Lecture 16 - Taylor Flow : Meat Transfer 2

Lecture 17 - Flow boiling in microchannels

Lecture 18 - Flow boiling in microchannels (Continued...)

Lecture 19 - Flow Measurement Techniques

Lecture 20 - Particle image Velocimetry

Lecture 21 - Inertial Microfluidics

Lecture 22 - Microfluidic applications

Lecture 23 - Microfluidic applications (Continued...)

Lecture 24 - Concluding Remarks



Lecture 1 - Introduction to Multiphase flow Measurement Techniques

Lecture 2 - Invasive and Non-invasive Techniques

Lecture 3 - Hot Wire Anemometry

Lecture 4 - Optical Fiber Probe

Lecture 5 - Laser Doppler Anemometry (LDA)

Lecture 6 - LDA Post Processing and Particle Image Velocimetry (PIV)

Lecture 7 - PIV and Positron Emission Particle Tracking

Lecture 8 - Radioactive Particle Tracking - I

Lecture 9 - Radioactive Particle Tracking - II

Lecture 10 - Capacitance Probe, Optical Fiber Probe and ECT

Lecture 11 - Gamma-ray and X-ray Tomography, MRI

Lecture 12 - Summary

Lecture 1 - Multiphase flow introduction

Lecture 2 - Fundamental definitions and terminology used in Multiphase - I

Lecture 3 - Fundamental definitions and terminology used in Multiphase - II

Lecture 4 - Flow Regime Map for Gas-Liquid System

Lecture 5 - Flow Regime Map for Fluid-Solid System

Lecture 6 - Pneumatic Conveying

Lecture 7 - Momentum Equation through Reynolds Transport Theorem

Lecture 8 - Lockhart Martinelli Correlation

Lecture 9 - Pressure Drop Calculation for Homogeneous Flow

Lecture 10 - Pressure Drop Calculation for Separated and Annular Flow Regime

Lecture 11 - Lagrangian Tracking of Single Particle Under Different Forces

Lecture 12 - Multiphase Interactions: Drag Force

Lecture 13 - Multiphase Interactions: Multi-particle Drag, Virtual Mass Force, Basset Force and Lift Force

Lecture 14 - Introduction to Multiphase Flow Modeling

Lecture 15 - Algebraic Slip Method and Euler-Euler Method

Lecture 16 - KTGF and Euler-Lagrangian Model

Lecture 17 - Measurement Techniques: Velocity Measurement

Lecture 18 - Measurement Techniques: Phase Fraction Measurement

Lecture 19 - Bubble Column

Lecture 20 - Packed Bed Reactor

Lecture 21 - Fluidized Bed Reactor

Lecture 22 - Summary

Lecture 1 - Introduction to Polymers

Lecture 2 - Ideal Chain Models

Lecture 3 - Ideal and Real Chains

Lecture 4 - Thermodynamics of Polymer Solutions - I

Lecture 5 - Thermodynamics of Polymer Solutions - II

Lecture 6 - Thermodynamics of Polymer Solutions - III

Lecture 7 - Phase Behaviour of Polymer Solutions and Blends

Lecture 8 - Phase Behaviour of Polymer Blends and Copolymers

Lecture 9 - Determination of Polymer Molar Mass: Osmometry

Lecture 10 - Determination of Polymer Molar Mass: Static Light Scattering - I

Lecture 11 - Determination of Polymer Molar Mass: Static Light Scattering - II

Lecture 12 - Determination of Polymer Molar Mass: Viscometry and GPC

Lecture 13 - Branching: Hyperbranched Polymers

Lecture 14 - Branching, Network Formation and Gelation

Lecture 15 - Gelation and Swelling of Network Polymers

Lecture 16 - Amorphous State of Polymers

Lecture 17 - Crystalline State of Polymers

Lecture 18 - Mechanical Properties of Polymers

Lecture 19 - Viscoelasticity: Mechanical Models

Lecture 20 - Viscoelasticity, Dynamic Mechanical Analysis and Rheology

Lecture 21 - Rubber Elasticity

Lecture 22 - Unentangled Polymer Dynamics

Lecture 23 - Entangled Polymer Dynamics

Lecture 24 - Review

- Lecture 1 - Introduction to Natural Gas - I
- Lecture 2 - Introduction to Natural Gas - II
- Lecture 3 - Introduction to Natural Gas - III
- Lecture 4 - Wellbore Performance Relationship (WPR)
- Lecture 5 - Choke Performance Relationship (CPR)
- Lecture 6 - Nodal Analysis
- Lecture 7 - Inflow Performance Relationship (IPR) - I
- Lecture 8 - Inflow Performance Relationship (IPR) - II
- Lecture 9 - Gas Well Testing
- Lecture 10 - Wellbore Performance Relationship (WPR)
- Lecture 11 - Choke Performance Relationship (CPR)
- Lecture 12 - Nodal Analysis
- Lecture 13 - Natural Gas Separation - I
- Lecture 14 - Natural Gas Separation - II
- Lecture 15 - Dehydration of Natural Gas
- Lecture 16 - Sweetening of Natural Gas
- Lecture 17 - Compressor Design
- Lecture 18 - Measurement of Natural Gas
- Lecture 19 - Transportation of Natural Gas - I
- Lecture 20 - Transportation of Natural Gas - II
- Lecture 21 - Unconventional production of Natural Gas
- Lecture 22 - Review: Concluding Remarks

Lecture 1 - Introduction

Lecture 2 - First law for closed systems

Lecture 3 - First law for open systems

Lecture 4 - Simple processes

Lecture 5 - Processes involving liquids and ideal gases

Lecture 6 - Temperature dependency of  $C_p$  in an ideal gas

Lecture 7 - Efficiency of Heat engines and Statement of Second Law

Lecture 8 - Entropy

Lecture 9 - Lost Work

Lecture 10 - Maxwell's Relations

Lecture 11 - Thermodynamic Diagrams

Lecture 12 - Thermodynamic Tables, Residual Properties

Lecture 13 - Virial Equation of State

Lecture 14 - Residual property relations from EoS

Lecture 15 - Cubic Equation of State

Lecture 16 - Cubic Equation of State

Lecture 17 - Thermodynamic Tables

Lecture 18 - Correlations for Liquids

Lecture 19 - Process Involving Phase Changes

Lecture 20 - Chemical potential

Lecture 21 - Partial molar properties

Lecture 22 - Examples

Lecture 23 - Ideal Solutions

Lecture 24 - Excess Properties

Lecture 25 - Fugacity

Lecture 26 - Calculation of Fugacity using EoS - Part 1

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- Lecture 3 - Infrared Spectroscopy: Fundamentals
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- Lecture 7 - NMR: Concepts and Fundamentals
- Lecture 8 - Chemical Shifts
- Lecture 9 - Factors Affecting Chemical Shift and 2D NMR
- Lecture 10 - Physisorption: Surface Area and Pore Analysis
- Lecture 11 - Physisorption Measurements
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- Lecture 13 - Surface Tension and its Measurement - Part 1
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- Lecture 15 - Interfacial Tension and its Application
- Lecture 16 - Interfacial Tension and Influence of Surface Curvature
- Lecture 17 - Rheology: Fundamentals and Principles
- Lecture 18 - Complex Fluids and their Properties
- Lecture 19 - Rheology: Case Study on Hydrogel Synthesis
- Lecture 20 - Electron Spectroscopy for Surface Analysis
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- Lecture 22 - XPS Instrument and Application
- Lecture 23 - Introduction to Electrochemical Characterization Techniques
- Lecture 24 - Electrode Potential, Kinetics and Mass Transfer Resistance
- Lecture 25 - Voltammetry and Galvanostatic Charge-Discharge

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- Lecture 2 - Structure of Chemical Industry
- Lecture 3 - Safety and Loss Prevention
- Lecture 4 - Sulfuric Acid: Reactions and Thermodynamics
- Lecture 5 - SO<sub>2</sub> Conversion Reactor and Sulfuric Acid Production Process
- Lecture 6 - Sulfur Production: Claus Process
- Lecture 7 - Synthesis Gas Production
- Lecture 8 - Coal Gasification
- Lecture 9 - Coal Gasifiers
- Lecture 10 - Gasification Technology and Applications
- Lecture 11 - Thermodynamics of Ammonia Synthesis
- Lecture 12 - Integrated Ammonia Plant and Hydrogen Recovery - I
- Lecture 13 - Integrated Ammonia Plant and Hydrogen Recovery - II
- Lecture 14 - Urea Production
- Lecture 15 - Nitric acid: Reactions and Thermodynamics
- Lecture 16 - Production of Phosphoric Acid: Dihydrate Process
- Lecture 17 - Production of Phosphoric Acid: Hemihydrate Process
- Lecture 18 - Emission Abatement in Phosphoric Acid Plants
- Lecture 19 - Chlorine Production
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- Lecture 21 - Heterogeneous Catalysis
- Lecture 22 - Catalysis with Zeolites and production of Iso-butene
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- Lecture 24 - Periodic Flow Reversal and Production of Styrene
- Lecture 25 - Selective Oxidation Processes and Ethene Production
- Lecture 26 - Monolith Reactors for Automotive Emission
- Lecture 27 - Methanol Production
- Lecture 28 - Methanol and Formaldehyde Production
- Lecture 29 - Fischer-Tropsch Synthesis
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Lecture 12 - Sulfur and sulfuric acid

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Lecture 14 - Nitrogen Industries - Ammonia

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- Lecture 5 - Vegetable Oils and Processing
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- Lecture 7 - Soaps and Glycerine Manufacture
- Lecture 8 - Detergents Manufacture
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- Lecture 13 - Fermentation Industry – Ethanol
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Lecture 2 - Characteristics of Single particle

Lecture 3 - Particle size and Its distribution in mixture

Lecture 4 - Mechanism of Size Reduction

Lecture 5 - General Machines for Size Reduction

Lecture 6 - Laws of Energy for Size Reduction

Lecture 7 - Introduction on Size Enlargement

Lecture 8 - Mechanism of Size Enlargement

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Lecture 11 - Terminal velocity of single particle

Lecture 12 - Multiple particle Interaction/Sedimentation: Hindered settling velocity

Lecture 13 - Basic law and terminology of flow through granular bed

Lecture 14 - General expressions for flow through packed beds-Ergun Equation

Lecture 15 - Two-phase flow through packed bed

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Lecture 17 - Degree of mixing and Its Assessment

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Lecture 9 - Solid fuels - Part II

Lecture 10 - Liquid fuels - Part I

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Lecture 12 - Practice problems - Part I

Lecture 13 - Practice problems - Part II

Lecture 14 - Energy from Bio-based Feedstock

Lecture 15 - Thermal/Thermochemical processes

Lecture 16 - Practice problems (Pelletization)

Lecture 17 - Practice problems (Torrefaction Mass and Energy Yield)

Lecture 18 - Pyrolysis and Hydrothermal Liquefaction

Lecture 19 - Gasification

Lecture 20 - Practice examples (Pyrolysis, Gasification)

Lecture 21 - Biochemical conversion processes - Anaerobic Digestion in Landfills

Lecture 22 - Bioethanol Production

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Lecture 24 - Chemical Conversion Processes - Types of Feedstock and Pretreatment

Lecture 25 - Mechanism of trans-esterification and biodiesel production

Lecture 26 - Green diesel synthesis from bio-based feedstocks

Lecture 27 - Energy from Coal (Carbonization, Gasification and Liquefaction)

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- Lecture 3 - Properties of Canonical Partition Function
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- Lecture 5 - Thermodynamic Properties of Ideal Monoatomic Gases
- Lecture 6 - Monoatomic Gases and Gibbs Entropy Equation
- Lecture 7 - Energy Fluctuations for Monoatomic Gases
- Lecture 8 - Partition Function for Diatomic Gases
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- Lecture 15 - Degree of Ionization of Gas Molecules
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- Lecture 17 - Microcanonical and Grand Canonical Ensemble
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- Lecture 20 - Semi Grand Canonical Ensemble and Comparison of Ensembles
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**NPTEL : Fluid Mechanics (Chemical Engineering)**

**Co-ordinators : Dr. V. Shankar**

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**NPTEL : Mass Transfer II (Chemical Engineering)**

**Co-ordinators : Prof. Nishith Verma**

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- Lecture 4 - Common Industrial Control Loops and advanced loops
- Lecture 5 - Advanced loops (Continued...) and multivariable systems
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- Lecture 7 - Frequency Domain Analysis
- Lecture 8 - Multivariable Systems
- Lecture 9 - RGA and dynamic decoupling
- Lecture 10 - Model based control
- Lecture 11 - Dynamic Matrix Control
- Lecture 12 - Control of Distillation Columns
- Lecture 13 - Temperature inferential distillation control
- Lecture 14 - Considerations in temperature inferential control
- Lecture 15 - Control of Complex Column Configurations
- Lecture 16 - Control of Heat Integrated Columns
- Lecture 17 - Homogenous extractive distillation
- Lecture 18 - More on complex columns and reactive distillation
- Lecture 19 - Control of reactors
- Lecture 20 - PFR controls (Continued..) & CSTRs
- Lecture 21 - CSTR heat management
- Lecture 22 - Heat Exchangers and Miscellaneous Systems
- Lecture 23 - Degrees of freedom analysis
- Lecture 24 - Degrees of freedom (Continued...)
- Lecture 25 - Illustration of considerations in control structure synthesis
- Lecture 26 - Two column recycle process
- Lecture 27 - Throughput manipulator selection
- Lecture 28 - Plantwide control structure design
- Lecture 29 - Systematizing plantwide control design
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- Lecture 31 - Role of equipment capacity constraints

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Lecture 2 - Review - Temperature and Pressure

Lecture 3 - Review - Energy Conservation

Lecture 4 - Properties - Part 1

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Lecture 16 - Maxwell Relation

Lecture 17 - Stability Criteria

Lecture 18 - Thermodynamics of phase equilibrium

Lecture 19 - Chemical potential and fugacity

Lecture 20 - General discussion on fugacity

Lecture 21 - Ideal Gas Mixture - Part 1

Lecture 22 - Ideal Gas Mixture - Part 2

Lecture 23 - Partial Molar Properties

Lecture 24 - Partial Molar Properties from experimental data

Lecture 25 - Thermodynamics properties from volumetric data - 1

Lecture 26 - Thermodynamics properties from volumetric data - 2

Lecture 27 - Fugacity of pure liquids and solids

Lecture 28 - Thermodynamics properties from volumetric data: effect of V and T

Lecture 29 - Approaches to phase equilibria calculation

Lecture 30 - Traditional Approaches to phase equilibria calculations

Lecture 31 - Algorithms for vapor-liquid equilibria

- Lecture 32 - Probability and Multiplicity
- Lecture 33 - Multiplicity and maximising the multiplicity
- Lecture 34 - Introduction to statistical mechanics
- Lecture 35 - Partition function for independent particles
- Lecture 36
- Lecture 37 - Models of Molecular Pair Potentials
- Lecture 38 - Molecular Theory of Corresponding States
- Lecture 39 - Molecular Interactions in Dense Fluid Media
- Lecture 40 - Models for Electrolyte Systems
- Lecture 41 - Membrane Osmometry
- Lecture 42 - Fugacity of liquid mixture - 1
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- Lecture 44 - Models for fugacity of liquid mixtures - 1
- Lecture 45 - Models for fugacity of liquid mixtures - 2
- Lecture 46 - Examples of Fugacity of liquids
- Lecture 47 - Stability of the Fluid Phases
- Lecture 48 - Theories of Solution - I
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Lecture 6 - Driving force for the matter flow

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Lecture 16 - Maximum work and entropy of ideal gas

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Lecture 18 - Mathematical properties of fundamental equations

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Lecture 23 - Jacobian method and its applications

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- Lecture 3 - Virus and Cell Organelles
- Lecture 4 - Carbohydrate
- Lecture 5 - Nucleic Acid
- Lecture 6 - Lipids
- Lecture 7 - Proteins
- Lecture 8 - Biochemistry & Thermodynamics of Enzymes
- Lecture 9 - Enzyme Kinetics : Michealis-Menten Kinetics
- Lecture 10 - Regulation of Enzyme Activity : Inhibition
- Lecture 11 - Regulation of Enzyme Activity : Inhibition (Continued...)
- Lecture 12 - Effects of Substrate and Inhibition, pH and Temperature on Enzyme Activity
- Lecture 13 - Immobilized Enzymes
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- Lecture 15 - Interphase Mass Transfer and Reaction in Immobilized Enzymes
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- Lecture 17 - Effectiveness Factor in Immobilized Enzymes
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- Lecture 19 - TCA Cycle
- Lecture 20 - Electron Transport Chain & Oxidative Phosphorylation
- Lecture 21 - Pentose Phosphate Pathways Glycogenesis & Glycogenolysis
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- Lecture 23 - Microbial Growth : Phases and Models
- Lecture 24 - Effect of Mass Transfer on Microbial & Fungal Growth
- Lecture 25 - Effect of Multiple Substrates and Inhibition on Microbial Growth
- Lecture 26 - Design of Bioreactors
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- Lecture 28 - Stability of Bioreactors
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- Lecture 30 - Introduction to Receptor - Ligand Binding
- Lecture 31 - Effects of Ligand Depletion and Multiple Receptors on Binding Kinetics

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**NPTEL : Multiphase Flow (Chemical Engineering)**

**Co-ordinators : Prof. P.K. Das, Prof. Gargi Das**

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Lecture 2 - Estimation of Flow Patterns

Lecture 3 - Estimation of Flow Patterns (Continued...)

Lecture 4 - Flow Pattern Maps Fascinating Taylor Bubbles

Lecture 5 - Definitions and Common Terminologies

Lecture 6 - Definitions and Common Terminologies (Continued...)

Lecture 7 - Simple Analytical Models

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**Co-ordinators : Prof. S. De**

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- Lecture 54 - Introduction to z-transforms
- Lecture 55 - z-transforms Continued
- Lecture 56 - Response of discrete-time systems
- Lecture 57 - Response of discrete-time systems (Continued...)
- Lecture 58 - Response of discrete-time systems (Continued...)
- Lecture 59 - Stability analysis in transform domain
- Lecture 60 - Review of the course

**NPTEL : NOC:Metallocene and Metal-Carbene based Organometallic Compounds as Industrially Important Advanced Polyolefin Catalysts (Chemical Engineering)**

**Co-ordinators : Prof. Sanjib K. Patra**

Lecture 1 - A Brief Introduction to Polymers

Lecture 2 - A Brief Introduction to Polymers (Continued...)

Lecture 3 - Polyethylene and Polypropylene: Chemical structure and properties

Lecture 4 - Polyethylene and Polypropylene: Chemical structure and properties (Continued...)

Lecture 5 - Common polymerization protocol and mechanism

Lecture 6 - Common polymerization protocol and mechanism (Continued...)

Lecture 7 - Common polymerization protocol and mechanism: Controlled Polymerization

Lecture 8 - Anionic living polymerization and Coordination polymerization

Lecture 9 - Transition metal/Organometallic complexes: Unique reactions

Lecture 10 - Metallocene compounds: Structure and Bonding

Lecture 11 - Metallocene compounds: Structure and Bonding (Continued...)

Lecture 12 - Bonding in Metallocene, MOT and Electronic nature

Lecture 13 - Bonding and Electronic nature in Bent Metallocene

Lecture 14 - Bonding and Electronic nature in Bent Metallocene (Continued...)

Lecture 15 - General Synthetic Strategies for Metallocenes (Parallel and Bent)

Lecture 16 - Properties and Unique Reactivities of parallel and bent Metallocenes

Lecture 17 - Unique Reactivities of bent Metallocenes

Lecture 18 - Unique Reactivities of bent Metallocenes (Continued...)

Lecture 19 - Coordination polymerization of olefin and stereoregularity

Lecture 20 - Olefin polymerization by Zeigler Natta Catalyst: Important features

Lecture 21 - Coordination polymerization of olefin by Metallocene Catalysts: A new avenue in polyolefin catalysts

Lecture 22 - Coordination polymerization of olefin by Metallocene Catalysts: A new avenue in polyolefin catalysts (Continued...)

Lecture 23 - Symmetry of metallocene and Stereoregularity in polyolefin

Lecture 24 - Symmetry of metallocene and Stereoregularity in polyolefin (Continued...)

Lecture 25 - Metallocene to Post-metallocene catalysts for olefin polymerization

Lecture 26 - Metallocene to Post-metallocene catalysts for olefin polymerization (Continued...)

Lecture 27 - Polymerization strategy for industrial preparation of LLDPE

Lecture 28 - Polymerization strategy for industrial preparation of LLDPE (Continued...)

Lecture 29 - Metallocene and Post-metallocene Catalysts: Homogeneous to Heterogeneous and Lab to Industry

Lecture 30 - Metallocene and Post-metallocene Catalysts: Homogeneous to Heterogeneous and Lab to Industry (Continued...)

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[Lecture 31 - Depolymerization of synthetic polymers: Role of organometallic and metallocene based catalysts](#)

[Lecture 32 - Depolymerization of synthetic polymers: Role of organometallic and metallocene based catalysts](#)

[Lecture 33 - Metal-carbene complexes as versatile catalysts for multiple useful reactions: A short introduction](#)

[Lecture 34 - Metal-carbene complexes as versatile catalysts for multiple useful reactions: A short introduction \(Continued...\)](#)

[Lecture 35 - Bonding and Electronic properties in Metal-carbene complexes](#)

[Lecture 36 - General synthetic protocol of Metal-carbene complexes](#)

[Lecture 37 - N-Heterocyclic carbene \(NHC\) complex: Bonding and General synthetic protocol](#)

[Lecture 38 - Alkene metathesis by metal-carbene catalysts and its mechanism](#)

[Lecture 39 - Utility of metal-carbene catalysts in alkene polymerization](#)

[Lecture 40 - Industrially important polymers by ROMP: Recent development and scope; Overall summary of this course](#)

- Lecture 1 - Introduction Basic Concepts and Kinematics - 1
- Lecture 2 - Kinematics - 2
- Lecture 3 - Kinematics - 3
- Lecture 4 - Kinematics - 4
- Lecture 5 - Kinematics - 5 - Shear Stress
- Lecture 6 - Kinematics - 6 and Conservation Equation - 1
- Lecture 7 - Conservation Equation - 2
- Lecture 8 - Conservation Equation - 3 - Conservation of Momentum
- Lecture 9 - Conservation Equation - 4 - Conservation of Momentum - 2
- Lecture 10 - Conservation Equation - 5 - Conservation of Momentum - 3
- Lecture 11 - Exact Solution - 1
- Lecture 12 - Exact Solution - 2
- Lecture 13 - Exact Solution - 3
- Lecture 14 - Exact Solution - 4
- Lecture 15 - Boundary Layer Analysis - 1
- Lecture 16 - Boundary Layer Analysis - 2
- Lecture 17 - Boundary Layer Analysis - 3
- Lecture 18 - Boundary Layer Analysis - 4: Blasius Solution - 1
- Lecture 19 - Boundary Layer Analysis - 4: Blasius Solution - 2
- Lecture 20 - Boundary Layer Analysis - 5: Momentum Integral Method - 1
- Lecture 21 - Boundary Layer Analysis - 6: Momentum Integral Method - 2
- Lecture 22 - Boundary Layer Analysis - 6: Momentum Integral Method - 3
- Lecture 23 - Turbulence - 1
- Lecture 24 - Turbulence - 2
- Lecture 25 - Turbulence - 3
- Lecture 26 - Turbulence - 4
- Lecture 27 - Turbulence - 5
- Lecture 28 - Turbulence - 6
- Lecture 29 - Turbulence - 7
- Lecture 30 - Turbulence - 8 and Final Wrap-up
- Lecture 31 - Fundamentals and Mechanism of Heat Transfer

- [Lecture 32 - Fundamentals and Mechanism of Heat Transfer \(Continued...\)](#)
- [Lecture 33 - Fundamentals and Mechanism of Heat Transfer \(Continued...\)](#)
- [Lecture 34 - Fundamentals and Mechanism of Heat Transfer \(Continued...\)](#)
- [Lecture 35 - Fundamentals and Mechanism of Heat Transfer \(Continued...\)](#)
- [Lecture 36 - One-dimensional Heat Conduction](#)
- [Lecture 37 - One-dimensional Heat Conduction \(Continued...\)](#)
- [Lecture 38 - One-dimensional Heat Conduction \(Continued...\)](#)
- [Lecture 39 - One-dimensional Heat Conduction \(Continued...\)](#)
- [Lecture 40 - One-dimensional Heat Conduction \(Continued...\)](#)
- [Lecture 41 - One-dimensional Heat Conduction \(Continued...\)](#)
- [Lecture 42 - One-dimensional Heat Conduction \(Continued...\)](#)
- [Lecture 43 - Transient Heat Conduction](#)
- [Lecture 44 - Transient Heat Conduction \(Continued...\)](#)
- [Lecture 45 - Transient Heat Conduction \(Continued...\)](#)
- [Lecture 46 - Forced Convection](#)
- [Lecture 47 - Forced Convection \(Continued...\)](#)
- [Lecture 48 - Forced Convection \(Continued...\)](#)
- [Lecture 49 - Forced Convection \(Continued...\)](#)
- [Lecture 50 - Forced Convection \(Continued...\)](#)
- [Lecture 51 - Internal Forced Convection](#)
- [Lecture 52 - Internal Forced Convection \(Continued...\)](#)
- [Lecture 53 - Internal Forced Convection \(Continued...\)](#)
- [Lecture 54 - Internal Forced Convection \(Continued...\)](#)
- [Lecture 55 - Internal Forced Convection \(Continued...\)](#)
- [Lecture 56 - Natural Convection](#)
- [Lecture 57 - Natural Convection \(Continued...\)](#)
- [Lecture 58 - Boiling and Condensation](#)
- [Lecture 59 - Radiation](#)
- [Lecture 60 - Radiation \(Continued...\)](#)



Lecture 1 - Introduction of Structure-Property-Process Correlation of Polymer, Elastomer and Composite - 1

Lecture 2 - Introduction of Structure-Property-Process Correlation of Polymer, Elastomer and Composite - 1

Lecture 3 - Introduction of Structure-Property-Process Correlation of Polymer, Elastomer and Composite - 1

Lecture 4 - Introduction of Structure-Property-Process Correlation of Polymer, Elastomer and Composite - 1

Lecture 5 - Introduction of Structure-Property-Process Correlation of Polymer, Elastomer and Composite - 1

Lecture 6 - Introduction of Structure-Property-Process Correlation of Polymer, Elastomer and Composite - 2

Lecture 7 - Introduction of Structure-Property-Process Correlation of Polymer, Elastomer and Composite - 2

Lecture 8 - Introduction of Structure-Property-Process Correlation of Polymer, Elastomer and Composite - 2

Lecture 9 - Introduction of Structure-Property-Process Correlation of Polymer, Elastomer and Composite - 2

Lecture 10 - Introduction of Structure-Property-Process Correlation of Polymer, Elastomer and Composite - 2

Lecture 11 - Identification by Chemical Techniques, Implication of National and International Standards alongwith Practical Demonstration

Lecture 12 - Identification by Chemical Techniques, Implication of National and International Standards alongwith Practical Demonstration (Continued...)

Lecture 13 - Identification by Chemical Techniques, Implication of National and International Standards alongwith Practical Demonstration (Continued...)

Lecture 14 - Identification by Chemical Techniques, Implication of National and International Standards alongwith Practical Demonstration (Continued...)

Lecture 15 - Identification by Chemical Techniques, Implication of National and International Standards alongwith Practical Demonstration (Continued...)

Lecture 16 - Introduction of UV-Vis and infrared spectroscopy for polymers, elastomers and composites

Lecture 17 - Introduction of UV-Vis and infrared spectroscopy for polymers, elastomers and composites (Continued...)

Lecture 18 - Introduction of UV-Vis and infrared spectroscopy for polymers, elastomers and composites (Continued...)

Lecture 19 - Introduction of UV-Vis and infrared spectroscopy for polymers, elastomers and composites (Continued...)

Lecture 20 - Introduction of UV-Vis and infrared spectroscopy for polymers, elastomers and composites (Continued...)

Lecture 21 - Application of infrared spectroscopy for blends, modification of polymers, compatibilizaion, coupling etc.

Lecture 22 - Application of infrared spectroscopy for blends, modification of polymers, compatibilizaion, coupling etc.

Lecture 23 - Application of infrared spectroscopy for blends, modification of polymers, compatibilizaion, coupling etc.

Lecture 24 - Practical demonstration on UV-Visible spectroscopy

Lecture 25 - Practical demonstration on FTIR spectroscopy and Sulphur analyzer

Lecture 26 - Introduction to Photoacoustic spectroscopy (PA), Raman spectroscopy, Atomic absorption spectroscopy and Electron spin response (ESR) spectroscopy

Lecture 27 - Introduction to Photoacoustic spectroscopy (PA), Raman spectroscopy, Atomic absorption spectroscopy and Electron spin response (ESR) spectroscopy (Continued...)

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Lecture 28 - Introduction to Photoacoustic spectroscopy (PA), Raman spectroscopy, Atomic absorption spectroscopy and Electron spin response (ESR) spectroscopy (Continued...)

Lecture 29 - Introduction to Photoacoustic spectroscopy (PA), Raman spectroscopy, Atomic absorption spectroscopy and Electron spin response (ESR) spectroscopy (Continued...)

Lecture 30 - Introduction to Photoacoustic spectroscopy (PA), Raman spectroscopy, Atomic absorption spectroscopy and Electron spin response (ESR) spectroscopy (Continued...)

Lecture 31 - NMR Spectroscopy- principles and fundamentals. Application of NMR in polymer, elastomer and composites

Lecture 32 - NMR Spectroscopy- principles and fundamentals. Application of NMR in polymer, elastomer and composites (Continued...)

Lecture 33 - NMR Spectroscopy- principles and fundamentals. Application of NMR in polymer, elastomer and composites (Continued...)

Lecture 34 - NMR Spectroscopy- principles and fundamentals. Application of NMR in polymer, elastomer and composites (Continued...)

Lecture 35 - NMR Spectroscopy- principles and fundamentals. Application of NMR in polymer, elastomer and composites (Continued...)

Lecture 36 - Thermal analysis techniques and application in polymer, elastomer and composites

Lecture 37 - Thermal analysis techniques and application in polymer, elastomer and composites (Continued...)

Lecture 38 - Thermal analysis techniques and application in polymer, elastomer and composites (Continued...)

Lecture 39 - Practical demonstration on TGA, DSC and DMA

Lecture 40 - XRD, XPS and XRF. Principles, Fundamentals and Application in Polymer, Elastomer and Composites

Lecture 41 - XRD, XPS and XRF. Principles, Fundamentals and Application in Polymer, Elastomer and Composites (Continued...)

Lecture 42 - XRD, XPS and XRF. Principles, Fundamentals and Application in Polymer, Elastomer and Composites (Continued...)

Lecture 43 - XRD, XPS and XRF. Principles, Fundamentals and Application in Polymer, Elastomer and Composites (Continued...)

Lecture 44 - XRD, XPS and XRF. Principles, Fundamentals and Application in Polymer, Elastomer and Composites (Continued...)

Lecture 45 - Introduction to microscopy (Optical, AFM) with special reference to electron microscopy (SEM, FESEM and HRTEM)

Lecture 46 - Introduction to microscopy (Optical, AFM) with special reference to electron microscopy (SEM, FESEM and HRTEM) (Continued...)

Lecture 47 - Introduction to microscopy (Optical, AFM) with special reference to electron microscopy (SEM, FESEM and HRTEM) (Continued...)

Lecture 48 - Introduction to microscopy (Optical, AFM) with special reference to electron microscopy (SEM, FESEM and HRTEM) (Continued...)

Lecture 49 - Introduction to microscopy (Optical, AFM) with special reference to electron microscopy (SEM, FESEM and HRTEM) (Continued...)

Lecture 50 - Applications of microscopy in polymers, elastomers and composites

Lecture 51 - Applications of microscopy in polymers, elastomers and composites (Continued...)

Lecture 52 - Practical demonstration on optical microscopy

Lecture 53 - Practical demonstration on atomic force microscopy (AFM)

Lecture 54 - Practical demonstration on image processing using standard software (Image)

Lecture 55 - Chromatography, DETA, Quantification from Rate Dependent Methods, Reverse Engineering and Recent Advances

Lecture 56 - Chromatography, DETA, Quantification from Rate Dependent Methods, Reverse Engineering and Recent Advances (Continued...)

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[Lecture 57 - Chromatography, DETA, Quantification from Rate Dependent Methods, Reverse Engineering and Recent Advances \(Continued...\)](#)

[Lecture 58 - Chromatography, DETA, Quantification from Rate Dependent Methods, Reverse Engineering and Recent Advances \(Continued...\)](#)

[Lecture 59 - Chromatography, DETA, Quantification from Rate Dependent Methods, Reverse Engineering and Recent Advances \(Continued...\)](#)

[Lecture 60 - Chromatography, DETA, Quantification from Rate Dependent Methods, Reverse Engineering and Recent Advances \(Continued...\)](#)

Lecture 1 - Motivation for the Lab Course

Lecture 2 - Analysis of the Need of Computers in Process Industries

Lecture 3 - Analysis of the Need of Computers in Process Industries (Continued...)

Lecture 4 - Discussion on Computational Tools available to Chemical Engineers

Lecture 5 - Analysis and Comparison of different Programming Languages

Lecture 6 - MATLAB Primer - Basic Features

Lecture 7 - MATLAB Primer - Writing Codes

Lecture 8 - MATLAB Primer - Coding (Continued...)

Lecture 9 - MATLAB Primer - Coding (Continued...)

Lecture 10 - MATLAB Primer - Plotting and Presentation of Results

Lecture 11 - LAB 1 - Analysis of Frictional Losses in Pipe Flows Problem Definition and Analysis

Lecture 12 - LAB 1 - Analysis of Frictional Losses in Pipe Flows Theory and Solution Strategy

Lecture 13 - LAB 1 - Analysis of Frictional Losses in Pipe Flows Solution of the Problem under ...

Lecture 14 - LAB 1 - Analysis of Frictional Losses in Pipe Flows Solution of the Problem under ...

Lecture 15 - LAB 1 - Analysis of Frictional Losses in Pipe Flows Presentation and Interpretation ...

Lecture 16 - LAB 2 - Steady-state Operation of a Diabatic CSTR Problem Definition and Analysis

Lecture 17 - LAB 2 - Steady-state Operation of a Diabatic CSTR Theory and Solution Strategy

Lecture 18 - LAB 2 - Steady-state Operation of a Diabatic CSTR Solution of the Problem under ...

Lecture 19 - LAB 2 - Steady-state Operation of a Diabatic CSTR Solution of the Problem under ...

Lecture 20 - LAB 2 - Steady-state Operation of a Diabatic CSTR Analysis and Presentation ...

Lecture 21 - LAB 3 - Analysis of multicomponent distillation Problem definition and analysis

Lecture 22 - LAB 3 - Analysis of Multicomponent Distillation Theory and Solution Strategy

Lecture 23 - LAB 3 - Analysis of Multicomponent Distillation Solution of the Problem under Various ...

Lecture 24 - LAB 3 - Analysis of Multicomponent Distillation Solution of the Problem under Various ...

Lecture 25 - LAB 3 - Analysis of Multicomponent Distillation Presentation and Analysis of Results

Lecture 26 - LAB 4 - Analysis of Cooling of a Solid Body in a Reservoir Problem Definition ...

Lecture 27 - LAB 4 - Analysis of Cooling of a Solid Body in a Reservoir Theory and Solution ...

Lecture 28 - LAB 4 - Analysis of Cooling of a Solid Body in a Reservoir Solution of the Problem ...

Lecture 29 - LAB 4 - Analysis of Cooling of a Solid Body in a Reservoir Solution of the Problem ...

Lecture 30 - LAB 4 - Analysis of cooling of a solid body in a reservoir Presentation ...

Lecture 31 - LAB 5 - Analysis of unsteady-state operation of cascade CSTR's Problem Definition ...

- Lecture 32 - LAB 5 - Analysis of unsteady-state operation of cascade CSTR's Theory and Solution ...
- Lecture 33 - LAB 5 - Analysis of unsteady-state operation of cascade CSTR's Solution of the Problem
- Lecture 34 - LAB 5 - Analysis of unsteady-state operation of cascade CSTR's Solution of the problem
- Lecture 35 - LAB 5 - Analysis of unsteady-state operation of cascade CSTR's Presentation ...
- Lecture 36 - LAB 6 - Analysis of Steady-state Heat Conduction in a 1-D rod
- Lecture 37 - LAB 6 - Analysis of Steady-state Heat Conduction in a 1-D rod
- Lecture 38 - LAB 6 - Analysis of steady-state Heat Conduction in a 1-D rod
- Lecture 39 - LAB 6 - Analysis of steady-state Heat Conduction in a 1-D rod
- Lecture 40 - LAB 6 - Analysis of steady-state Heat Conduction in a 1-D rod
- Lecture 41 - LAB 7 - Reaction-diffusion in a spherical catalyst pallet Problem definition and ...
- Lecture 42 - LAB 7 - Reaction-diffusion in a spherical catalyst pallet Theory and solution strategy
- Lecture 43 - LAB 7 - Reaction-diffusion in a spherical catalyst pallet Solution of the problem ...
- Lecture 44 - LAB 7 - Reaction-diffusion in a spherical catalyst pallet Solution of the problem ...
- Lecture 45 - LAB 7 - Reaction-diffusion in a spherical catalyst pallet Analysis and interpretation ...
- Lecture 46 - LAB 8 - Heat conduction in higher dimensions Problem definition and analysis
- Lecture 47 - LAB 8 - Heat conduction in higher dimensions Background theory and solution strategy
- Lecture 48 - LAB 8 - Heat conduction in higher dimensions Problem solution
- Lecture 49 - LAB 8 - Heat conduction in higher dimensions Problem solution (Continued...)
- Lecture 50 - LAB 8 - Heat conduction in higher dimensions Problem solution and analysis
- Lecture 51 - LAB 9 - Process economics and optimisation Problem definition and analysis
- Lecture 52 - LAB 9 - Process economics and optimisation Theory and solution strategy
- Lecture 53 - LAB 9 - Process economics and optimisation Solution of the problem
- Lecture 54 - LAB 9 - Process economics and optimisation Solution of the problem (Continued...)
- Lecture 55 - LAB 9 - Process economics and optimisation Solution of the problem and analysis of ...
- Lecture 56 - LAB 10 - Regression and curve - fitting of data Problem definition and analysis
- Lecture 57 - LAB 10 - Regression and curve - fitting of data Background theory and solution strategy
- Lecture 58 - LAB 10 - Regression and curve - fitting of data Problem solution
- Lecture 59 - LAB 10 - Regression and curve - fitting of data Problem solution (Continued...)
- Lecture 60 - Review of the course

Lecture 1 - What is Petroleum How it is stored under the earth Exploration of petroleum underground

Lecture 2 - Concept of Seismic Reflection, Introduction to Drilling

Lecture 3 - Drilling Mud and Mechanisms of Recovery of Petroleum

Lecture 4 - Composition of Crude Petroleum and Evaluation of Oil Stocks

Lecture 5 - Evaluation of Oil Stocks: Vaporization Characteristics

Lecture 6 - Primary Processing of Crude Oil: Desalting

Lecture 7 - Primary Processing of Crude Oil: Atmospheric Distillation Unit (ADU)

Lecture 8 - Primary Processing of Crude Oil: Reflux Systems, Vacuum Distillation Unit (VDU)

Lecture 9 - Products and Process Utilities in Primary Processing, Pipe Still Heater

Lecture 10 - Refinery Units

Lecture 11 - Secondary Processing: Decomposition of Residues: Thermal Cracking

Lecture 12 - Coking, Gasification and Steam Cracking

Lecture 13 - Secondary Processing: Decomposition of Residues: Hydrocracking

Lecture 14 - Secondary Processing: Decomposition of Residues: Catalytic Cracking

Lecture 15 - Secondary Processing: Decomposition of Residues: Process description of FCC

Lecture 16 - Properties and Testing of Petroleum Products

Lecture 17 - Properties and Testing of Petroleum Products (Continued...)

Lecture 18 - Properties and Testing of Petroleum Products (Continued...)

Lecture 19 - Properties and Testing of Petroleum Products (Continued...)

Lecture 20 - Properties and Testing of Petroleum Products (Continued...)

Lecture 21 - Petroleum fractions from distillation units

Lecture 22 - Petroleum fractions from distillation units (Continued...)

Lecture 23 - Petroleum fractions from distillation units (Continued...)

Lecture 24 - Petroleum fractions from distillation units (Continued...)

Lecture 25 - Petroleum fractions from distillation units (Continued...)

Lecture 26 - Upgradation of straight run cuts from atmospheric distillation unit

Lecture 27 - Upgradation of straight run cuts from atmospheric distillation unit (Continued...)

Lecture 28 - Upgradation of straight run cuts from atmospheric distillation unit (Continued...)

Lecture 29 - Upgradation of straight run cuts from atmospheric distillation unit (Continued...)

Lecture 30 - Upgradation of straight run cuts from distillation unit

Lecture 31 - Purification processes

[Lecture 32 - Purification processes \(Continued...\)](#)

[Lecture 33 - Bitumen preparation processes](#)

[Lecture 34 - Grease: preparation, description and application](#)

[Lecture 35 - Emission control and effluent treatment in refinery](#)

[Lecture 36 - Fundamentals of thermochemistry: Combustion](#)

[Lecture 37 - Fundamentals of thermochemistry: Flame](#)

[Lecture 38 - Fundamentals of thermochemistry: Adiabatic flame temperature](#)

[Lecture 39 - Fundamentals of thermochemistry: Burner](#)

[Lecture 40 - Fundamentals of thermochemistry: Internal Combustion engine](#)

Lecture 1 - Basic Introduction to Polymer

Lecture 2 - Structure Process Correlation

Lecture 3 - Basic Rheology

Lecture 4 - Classification of Fluids

Lecture 5 - Flow of Liquids Through Various Channels - 1

Lecture 6 - Flow of Liquids Through Various Channels - 2

Lecture 7 - Flow of Liquids Through Various Channels - 3

Lecture 8 - Introduction to Viscometers and Rheometers

Lecture 9 - Ostwald Viscometer, Brookfield Viscometer, Falling Piston Viscometers

Lecture 10 - ODR, MDR, RPA, PPR

Lecture 11 - DMA -In-Light of rheology

Lecture 12 - Master Curve and its Implications

Lecture 13 - Capillary Rheometer

Lecture 14 - Introduction to Paints and importance of rheology in paints

Lecture 15 - Rheology of paints - 1

Lecture 16 - Rheology of paints - 2

Lecture 17 - Rheology of Adhesives and Sealants

Lecture 18 - Rheology of Fiber and Plastics

Lecture 19 - Practical demonstration on Brookfield viscometer and Oswald viscometer

Lecture 20 - Practical demonstration on Mooney viscometer, ODR and MDR

Lecture 21 - Practical demonstration on RPA

Lecture 22 - Practical demonstration on PPR and DMA

Lecture 23 - Practical demonstration on Capillary Rheometer

Lecture 24 - Numerical Problems related to basic rheology

Lecture 25 - Importance of compounding and introduction to various compounding ingredients

Lecture 26 - Properties and role of various compounding ingredients

Lecture 27 - Surface treatment of reinforcing elements

Lecture 28 - Rheology of Elastomers

Lecture 29 - Importance of die swell (correlating with normal force differences)

Lecture 30 - Melt Fracture and other extrudate instabilities

Lecture 31 - Introduction to plastic and rubber mixing and blending



Lecture 32 - Various mixing equipment and their importance

Lecture 33 - Introduction to Two-Roll Mill and Mixing on Two - Roll Mill 1

Lecture 34 - Introduction to Two-Roll Mill and Mixing on Two - Roll Mill 2

Lecture 35 - Introduction to Internal mixture Kneaders and Mixing using Internal mixture and Kneaders

Lecture 36 - Practical demonstration of Rubber mixing on a two roll and using an internal mixer

Lecture 37 - Molding Techniques

Lecture 38 - Calendering

Lecture 39 - Extrusion

Lecture 40 - Rheology of Injection moulding process

Lecture 41 - Plastic and fiber-related processing

Lecture 42 - Numerical problems related to various processing techniques

Lecture 43 - Wire coating, Garvey die, Profile Extrusion

Lecture 44 - Introduction to FEA based computationalfluid mechanics on extrusion - 1

Lecture 45 - Introduction to FEA based computationalfluid mechanics on extrusion - 2

Lecture 46 - Introduction to FEA based computationalfluid mechanics on extrusion - 3

Lecture 47 - Practical demonstartion on FEA

Lecture 48 - Concluding remarks and commentson applied rheology for advanced learners

[Lecture 1 - Petroleum Formation Evaluation](#)

[Lecture 2 - Mud Logging](#)

[Lecture 3 - Mud Logging \(Continued...\)](#)

[Lecture 4 - Coring Operations](#)

[Lecture 5 - Coring Operations \(Continued...\)](#)

[Lecture 6 - Wireline Logging](#)

[Lecture 7 - Resistivity Log](#)

[Lecture 8 - Resistivity Log \(Continued...\)](#)

[Lecture 9 - Resistivity Log \(Continued...\)](#)

[Lecture 10 - Resistivity Log \(Continued...\)](#)

[Lecture 11 - Resistivity Log \(Continued...\)](#)

[Lecture 12 - Resistivity Log \(Continued...\)](#)

[Lecture 13 - Resistivity Log \(Continued...\)](#)

[Lecture 14 - Resistivity Log \(Continued...\)](#)

[Lecture 15 - Resistivity Log \(Continued...\)](#)

[Lecture 16 - Spontaneous Potential Log](#)

[Lecture 17 - Spontaneous Potential Log \(Continued...\)](#)

[Lecture 18 - Petrophysical Model](#)

[Lecture 19 - Petrophysical Model \(Continued...\)](#)

[Lecture 20 - Gamma Ray Log](#)

[Lecture 21 - Gamma Ray Log \(Continued...\)](#)

[Lecture 22 - Gamma Ray Log \(Continued...\)](#)

[Lecture 23 - Caliper Log](#)

[Lecture 24 - Porosity Logs](#)

[Lecture 25 - Density Porosity Log](#)

[Lecture 26 - Density Porosity Log \(Continued...\)](#)

[Lecture 27 - Density Porosity Log \(Continued...\)](#)

[Lecture 28 - Density Porosity Log \(Continued...\)](#)

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[Lecture 30 - Neutron Porosity Log](#)

[Lecture 31 - Neutron Porosity Log \(Continued...\)](#)

- [Lecture 32 - Neutron Porosity Log \(Continued...\)](#)
- [Lecture 33 - Neutron Porosity Log \(Continued...\)](#)
- [Lecture 34 - Neutron Porosity Log \(Continued...\)](#)
- [Lecture 35 - Sonic \(Acoustic\) Porosity Log](#)
- [Lecture 36 - Sonic Porosity Log \(Continued...\)](#)
- [Lecture 37 - Sonic Porosity Log \(Continued...\)](#)
- [Lecture 38 - Sonic Porosity Log \(Continued...\)](#)
- [Lecture 39 - Sonic Porosity Log \(Continued...\)](#)
- [Lecture 40 - NMR Log](#)
- [Lecture 41 - NMR Log \(Continued...\)](#)
- [Lecture 42 - Well Log interpretation](#)
- [Lecture 43 - Well Log interpretation \(Continued...\)](#)
- [Lecture 44 - Well Log interpretation \(Continued...\)](#)
- [Lecture 45 - Well Log interpretation \(Continued...\)](#)
- [Lecture 46 - Well Log Interpretation \(Continued...\)](#)
- [Lecture 47 - Well Log Interpretation \(Continued...\)](#)
- [Lecture 48 - Well Log Interpretation \(Continued...\)](#)
- [Lecture 49 - Well Log Interpretation \(Continued...\)](#)
- [Lecture 50 - Well Log Interpretation \(Continued...\)](#)
- [Lecture 51 - Formation Evaluation \(well log analysis\) Practical](#)
- [Lecture 52 - Formation tops and Core Data](#)
- [Lecture 53 - Formation Temperature and Shaliness](#)
- [Lecture 54 - Formation porosity and Water Saturation](#)
- [Lecture 55 - Permeability and Effective Porosity](#)
- [Lecture 56 - Determination of Archie Equation Parameters](#)
- [Lecture 57 - Lithology Determination](#)
- [Lecture 58 - Net Pay and Well Diagram](#)
- [Lecture 59 - Rock Typing](#)
- [Lecture 60 - Miscellaneous Topics](#)

**NPTEL : NOC:Momentum Transfer in Fluids (Chemical Engineering)**

**Co-ordinators : Prof. Somenath Ganguly, Prof. Sunando DasGupta**

Lecture 1 - Introduction and Basic Concepts

Lecture 2 - Elementary Framework

Lecture 3 - Elementary Framework (Continued...)

Lecture 4 - Elementary Framework (Continued...)

Lecture 5 - Elementary Framework (Continued...)

Lecture 6 - Shell Momentum Balance - 1

Lecture 7 - Shell Momentum Balance - 2

Lecture 8 - Shell Momentum Balance - 3

Lecture 9 - Shell Momentum Balance - 4

Lecture 10 - Limitations and General Approach - Continuity Equation

Lecture 11 - Elements of Inviscid Flow

Lecture 12 - Elements of Inviscid Flow (Continued...)

Lecture 13 - Elements of Inviscid Flow (Continued...)

Lecture 14 - Elements of Inviscid Flow (Continued...)

Lecture 15 - Elements of Inviscid Flow (Continued...)

Lecture 16 - Equations of Motion - Conceptual Derivation of NS Equations

Lecture 17 - Use of NS Equation for Solving Previous Problems

Lecture 18 - Equations of Motion and Applications - 1

Lecture 19 - Equations of Motion and Applications - 2

Lecture 20 - Equations of Motion and Applications - 3

Lecture 21 - Motion of fluid particles

Lecture 22 - Motion of fluid particles (Continued...)

Lecture 23 - Motion of fluid particles (Continued...)

Lecture 24 - Stream Function and Potential Function

Lecture 25 - Stream Function and Potential Function (Continued... )

Lecture 26 - Equations of Motion and Applications - 4

Lecture 27 - Equations of Motion and Applications - 5

Lecture 28 - Basic Equations in Integral Form - 1

Lecture 29 - Basic Equations in Integral Form - 2

Lecture 30 - Basic Equations in Integral Form - 3

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Lecture 4 - Forces acting on a control volume; Stress tensor; Derivation of the momentum conservation equation ; Closure problem; Deformation of a fluid element in fluid flow

Lecture 5 - Kinematics of deformation in fluid flow; Stress vs strain rate relation; Derivation of the Navier-Stokes equations

Lecture 6 - Equations governing flow of incompressible flow; Initial and boundary conditions; Wellposedness of a fluid flow problem

Lecture 7 - Equations for some simple cases; Generic scalar transport equation form of the governing equations; Outline of the approach to the solution of the N-S equations.

Lecture 8 - cut out the first 30s; Spatial discretization of a simple flow domain; Taylor's series expansion and the basis of finite difference approximation of a derivative; Central and one-sided difference approximations; Order of accuracy of finite difference ap

Lecture 9 - Finite difference approximation of pth order of accuracy for qth order derivative; cross -derivatives; Examples of high order accurate formulae for several derivatives

Lecture 10 - One -sided high order accurate approximations; Explicit and implicit formulations for the time derivatives

Lecture 11 - Numerical solution of the unsteady advection equation using different finite difference approximations

Lecture 12 - Need for analysis of a discretization scheme; Concepts of consistency, stability and convergence and the equivalence theorem of Lax ; Analysis for consistency

Lecture 13 - Statement of the stability problem; von Neumann stability analysis of the first order wave equation

Lecture 14 - Consistency and stability analysis of the unsteady diffusion equation; Analysis for two- and three -dimensional cases; Stability of implicit schemes

Lecture 15 - Interpretation of the stability condition; Stability analysis of the generic scalar equation and the concept of upwinding ; Diffusive and dissipative errors in numerical solution; Introduction to the concept of TVD schemes

Lecture 16 - Template for the generic scalar transport equation and its extension to the solution of Navier-Stokes equations for a compressible flow.

Lecture 17 - Illustration of application of the template using the MacCormack scheme for a three-dimensional compressible flow

Lecture 18 - Stability limits of MacCormack scheme; Limitations in extending compressible flow schemes to incompressible flows ; Difficulty of evaluation of pressure in incompressible flows and listing of various approaches

Lecture 19 - Artificial compressibility method and the streamfunction-vorticity method for the solution of NS equations and their limitations

Lecture 20 - Pressure equation method for the solution of NS equations

Lecture 21 - Pressure-correction approach to the solution of NS equations on a staggered grid; SIMPLE and its family of methods

Lecture 22 - Need for efficient solution of linear algebraic equations; Classification of approaches for the solution of linear algebraic equations.

Lecture 23 - Direct methods for linear algebraic equations; Gaussian elimination method

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Lecture 26 - Convergence analysis of basic iterative schemes; Diagonal dominance condition for convergence; Influence of source terms on the diagonal dominance condition; Rate of convergence

Lecture 27 - Application to the Laplace equation

Lecture 28 - Advanced iterative methods: Alternating Direction Implicit Method; Operator splitting

Lecture 29 - Advanced iterative methods; Strongly Implicit Procedure; Conjugate gradient method; Multigrid method

Lecture 30 - Illustration of the Multigrid method for the Laplace equation

Lecture 31 - Overview of the approach of numerical solution of NS equations for simple domains; Introduction to complexity arising from physics and geometry

Lecture 32 - Derivation of the energy conservation equation

Lecture 33 - Derivation of the species conservation equation; dealing with chemical reactions

Lecture 34 - Turbulence; Characteristics of turbulent flow; Dealing with fluctuations and the concept of time-averaging

Lecture 35 - Derivation of the Reynolds -averaged Navier -Stokes equations; identification of the closure problem of turbulence; Boussinesq hypothesis and eddy viscosity

Lecture 36 - Reynolds stresses in turbulent flow; Time and length scales of turbulence; Energy cascade; Mixing length model for eddy viscosity

Lecture 37 - One-equation model for turbulent flow

Lecture 38 - Two -equation model for turbulent flow; Numerical calculation of turbulent reacting flows

Lecture 39 - Calculation of near-wall region in turbulent flow; wall function approach; near-wall turbulence models

Lecture 40 - Need for special methods for dealing with irregular flow geometry; Outline of the Body-fitted grid approach ; Coordinate transformation to a general, 3-D curvilinear system

Lecture 41 - Transformation of the governing equations; Illustration for the Laplace equation; Appearance and significance of cross - derivative terms; Concepts of structured and unstructured grids.

Lecture 42 - Finite volume method for complicated flow domain; Illustration for the case of flow through a duct of triangular cross - section.

Lecture 43 - Finite volume method for the general case

Lecture 44 - Generation of a structured grid for irregular flow domain; Algebraic methods; Elliptic grid generation method

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Lecture 47 - Co -located grid approach for irregular geometries; Pressure correction equation for a co -located structured grid; Pressure correction equation for a co-located unstructured grid.

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Lecture 19 - Regression and Interpolation - Part 5

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Lecture 22 - CVD Applications: CVD of Silicon

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Lecture 11 - Design of non-catalytic gas solid reactors (Continued...)

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Lecture 16 - General Performance equation for non-catalytic gas solid reactions

Lecture 17 - Catalytic reactions (LHHW Kinetic model)

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Lecture 4 - Tutorial 1: Converting PDE to algebraic equation using FD approximation

Lecture 5 - Tutorial 1 (Continued...) Solution for algebraic equations using Gauss-Seidel Method

Lecture 6 - Flow in a triangular duct: Problem formulation

Lecture 7 - Flow in a triangular duct: Discretization of flow domain

Lecture 8 - Tutorial 2: Converting PDE to algebraic equation using Finite Volume method

Lecture 9 - Tutorial 2 (Continued...) Description of FV method and solution using G-S Method

Lecture 10 - Effect of grid spacing & upcoming course outline

Lecture 11 - Mass conservation equations

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Lecture 30 - Properties of Numerical Schemes: Stability analysis

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Lecture 11 - Hypothesis testing of means

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Lecture 14 - Hypothesis testing using confidence interval

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**NPTEL : System Identification (Chemical Engineering)**

**Co-ordinators : Dr. Arun K.Tangirala**

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**NPTEL : Synthetic and Natural Supramolecular Architectures: An Approach Towards Molecular Technology (Chemical Engineering)**

**Co-ordinators : Prof. Chebrolu Pulla Rao**

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Lecture 28 - Propylene, Propylene oxide and Isopropanol

Lecture 29 - Aromatics Production

Lecture 30 - Aromatics product profile, Ethyl benzene & Styrene, Cumene and phenol, Bisphenol, Aniline

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Lecture 31 - Introduction to polymer, Elastomer and Synthetic Fibre, Polymerisation

Lecture 32 - Polymers: Polyolefins, Polyethylene, Polypropylene Polystyrene

Lecture 33 - Polyvinylchloride, polycarbonate, thermoset resin: phenolformaldehyde, uriaformaldehyde and melamineformaldehyde

Lecture 34 - Elastomers: Styrene butadiene Rubber(SBR), Poly butadiene, Nitrile rubber

Lecture 35 - Polymides or Nylons(PA)

Lecture 36 - DMT and Terephtalic Acid, Polyester, PET resin, PTB resin

Lecture 37 - Acrylic Fibre, Modified Acrylic Fibre, Acrylonitrile, Acrolein, Propylene Finber, Polyurethane

Lecture 38 - Viscose Rayon and Acetate rayon

Lecture 39 - Pesticide

Lecture 40 - Dye and Intermediates

**NPTEL : Process Integration (Chemical Engineering)**

**Co-ordinators : Dr. B. Mohanty**

- Lecture 1 - Process integration, methods and area of application
- Lecture 2 - Fundamental concepts related to heat integration - Part 1
- Lecture 3 - Fundamental concepts related to heat integration - Part 2
- Lecture 4 - Data extraction
- Lecture 5 - Hot composite curves
- Lecture 6 - Cold composite curves
- Lecture 7 - Hot and cold composite curves and the pinch
- Lecture 8 - Threshold problems
- Lecture 9 - Energy targeting procedure
- Lecture 10 - Problem Table Algorithm - Part 1
- Lecture 11 - Grand composite curve
- Lecture 12 - Problem Table Algorithm - Part 2
- Lecture 13 - Number of units target
- Lecture 14 - Shell targeting - Part 1
- Lecture 15 - Area targeting - Part 1
- Lecture 16 - Area targeting - Part 2
- Lecture 17 - Coast targeting - Part 1
- Lecture 18 - Coast targeting - Part 2
- Lecture 19 - Supertargeting- optimization of  $\hat{I}^* t \text{ min}$
- Lecture 20 - Global & stream specific  $\hat{I}^* t \text{ min}$  and its relevance
- Lecture 21 - Topology Trap
- Lecture 22 - Rules for Pinch Design Method (PDM) - Part 1
- Lecture 23 - Rules for Pinch Design Method (PDM) - Part 2
- Lecture 24 - Application of PDM for MER Hen Synthesis
- Lecture 25 - Design for threshold problems
- Lecture 26 - Design for single pinch problems
- Lecture 27 - Design for multi pinch problems
- Lecture 28 - HEN optimization
- Lecture 29 - Remaining problem analysis
- Lecture 30 - Driving Force Plot
- Lecture 31 - Low Temperature process Design - Part 1

[Lecture 32 - Low Temperature process Design - Part 2](#)

[Lecture 33 - Integration of Gas turbine with process - Part 1](#)

[Lecture 34 - Integration of Gas turbine with process - Part 2](#)

[Lecture 35 - Placement and Integration of Distillation Column](#)

[Lecture 36 - Heat Integration of evaporators](#)

[Lecture 37 - Integration of heat pump](#)

[Lecture 38 - Placement of Heat Engine, Heat pump and Reactors](#)

[Lecture 39 - Integration of Furnace](#)

[Lecture 40 - Problem solving using HINT Software - Part 1](#)

[Lecture 41 - Problem solving using HINT Software - Part 2](#)

[Lecture 42 - Problem solving using HINT Software - Part 3](#)

[Lecture 43 - Problem solving using HINT Software - Part 4](#)

**NPTEL : Mechanical Operations (Chemical Engineering)**

**Co-ordinators : Prof. Shabina Khanam**

Lecture 1 - Introduction

Lecture 2 - Characterization of a single particle - 1

Lecture 3 - Characterization of a single particle - 2

Lecture 4 - Characterization of collection of particles - 1

Lecture 5 - Characterization of collection of particles - 2

Lecture 6 - Fine grain size distribution

Lecture 7 - Effectiveness of screen - 1

Lecture 8 - Effectiveness of screen - 2

Lecture 9 - Industrial screening equipment

Lecture 10 - Size reduction

Lecture 11 - Laws of comminution

Lecture 12 - Examples of Laws of comminution - 1

Lecture 13 - Examples of Laws of comminution - 2

Lecture 14 - Size reduction equipment - 1

Lecture 15 - Size reduction equipment - 2

Lecture 16 - Particle dynamics - 1

Lecture 17 - Particle dynamics - 2

Lecture 18 - Particle dynamics-Examples

Lecture 19 - Classification and Jigging - 1

Lecture 20 - Classification and Jigging - 2



Lecture 1 - Introduction - 1

Lecture 2 - Introduction - 2

Lecture 3 - Characterization of wastes - 1

Lecture 4 - Characterization of wastes - 2

Lecture 5 - Characterization of wastes - 3

Lecture 6 - Tutorial on Chatacterization of wastes

Lecture 7 - Energy production from wastes through incineration - 1

Lecture 8 - Energy production from wastes through incineration - 2

Lecture 9 - Tutorial on incineration

Lecture 10 - Energy production from wastes through gasification - 1

Lecture 11 - Energy production from wastes through gasification - 2

Lecture 12 - Syngas utilization - 1

Lecture 13 - Syngas utilization - 2

Lecture 14 - Energy production from wastes through pyrolysis - 1

Lecture 15 - Energy production from wastes through pyrolysis - 2

Lecture 16 - Tutorial on gasification

Lecture 17 - Tutorial on Pyrolysis

Lecture 18 - Densification of solids - 1

Lecture 19 - Densification of solids - 2

Lecture 20 - Efficiency improvement of power plant - 1

Lecture 21 - Efficiency improvement of power plant - 2

Lecture 22 - Energy production from waste plastics - 1

Lecture 23 - Energy production from waste plastics - 2

Lecture 24 - Gas clean up - 1

Lecture 25 - Gas clean up - 2

Lecture 26 - Energy production from organic wastes through anaerobic digestion - 1

Lecture 27 - Energy production from organic wastes through anaerobic digestion - 2

Lecture 28 - Design of anaerobic digester

Lecture 29 - Introduction to Microbial fuel cells

Lecture 30 - Energy production from organic wastes through fermentation - 1

Lecture 31 - Energy production from organic wastes through fermentation - 2

[Lecture 32 - Tutorial on anaerobic digestion](#)

[Lecture 33 - Tutorial on fermentation](#)

[Lecture 34 - Energy production from wastes through transesterification - 1](#)

[Lecture 35 - Energy production from wastes through transesterification - 2](#)

[Lecture 36 - Tutorial on transesterification](#)

[Lecture 37 - Cultivation of algal biomass and treatment of waste water - 1](#)

[Lecture 38 - Cultivation of algal biomass and treatment of waste water - 2](#)

[Lecture 39 - Energy production form algal biomass - 1](#)

[Lecture 40 - Energy production form algal biomass - 2](#)

Lecture 1 - Introduction

Lecture 2 - Sedimentation and Batch Sedimentation Test - 1

Lecture 3 - Sedimentation and Batch Sedimentation Test - 2

Lecture 4 - Centrifugal Sedimentation and Equipment - 1

Lecture 5 - Centrifugal Sedimentation and Equipment - 2

Lecture 6 - Filtration - 1

Lecture 7 - Filtration - 2

Lecture 8 - Filtration - 3

Lecture 9 - Continuous Filtration - 1

Lecture 10 - Continuous Filtration - 2

Lecture 11 - Fluidisation - 1

Lecture 12 - Fluidisation - 2

Lecture 13 - Liquid Fluidisation

Lecture 14 - Gas Fluidisation - 1

Lecture 15 - Gas Fluidisation - 2

Lecture 16 - Flotation - 1

Lecture 17 - Flotation - 2

Lecture 18 - Transportaion of solids - 1

Lecture 19 - Transportaion of solids - 2

Lecture 20 - Transportaion of solids - 3

- Lecture 1 - Introduction to the course, Macromolecules and Life, Molecular flexibility
- Lecture 2 - Classification of polymers, Types of polymerization, Average molecular weights and polydispersity
- Lecture 3 - Motivation to study polymer physics
- Lecture 4 - Random Walk Models of Single Chain I: end-to-end distance of a polymer chain, freely jointed chain, drunkard walk
- Lecture 5 - Random Walk Models of Single Chain II: general random walk on a lattice
- Lecture 6 - Random Walk Models of Single Chain III: Freely rotating chain, definition of persistence length
- Lecture 7 - Models of semiflexible chains (Kratky Porod Model) - Part I
- Lecture 8 - Models of semiflexible chains (Kratky Porod Model) - Part II
- Lecture 9 - Probability density of an ideal chain - Part I
- Lecture 10 - Probability density of an ideal chain - Part II
- Lecture 11 - Entropic Elasticity, Bead-Spring Model, Simulations of random walk models
- Lecture 12 - Derivation of Diffusion equation, Einstein notation
- Lecture 13 - Definition of Radius of gyration
- Lecture 14 - Radius of gyration for an ideal chain, concept of ideality
- Lecture 15 - Nonbonded interactions, hydrophobic and hydrophilic behaviour
- Lecture 16 - Definition of excluded volume; good, bad, and theta solvent
- Lecture 17 - Virial expansion, Flory theory for good solvent
- Lecture 18 - Flory theory for bad solvent, self-similarity and fractal nature of polymers
- Lecture 19 - Derivation of fractal dimension, concentration regimes and overlap concentration
- Lecture 20 - Size, shape, and structure. Gyration tensor and measures of asphericity.
- Lecture 21 - Order-disorder transition
- Lecture 22 - Scattering experiments, Pair correlation function
- Lecture 23 - Structure of polymer chain, Introduction to Monte Carlo simulations of polymer chains
- Lecture 24 - Monte Carlo algorithm: Detailed Balance, Metropolis algorithm
- Lecture 25 - Practical aspects of Monte Carlo simulation
- Lecture 26 - Molecular Dynamics Simulations, Review of Thermodynamics
- Lecture 27 - Solution Thermodynamics - I
- Lecture 28 - Solution Thermodynamics - II
- Lecture 29 - Solution Thermodynamics - III
- Lecture 30 - Solution Thermodynamics - IV
- Lecture 31 - Phase separation regime, Introduction to lattice model of solutions

[Lecture 32 - Lattice Model of Solutions - I](#)

[Lecture 33 - Lattice Model of Solutions - II](#)

[Lecture 34 - Phase behaviour of liquid solutions](#)

[Lecture 35 - Lattice models of polymeric systems](#)

[Lecture 36 - Brownian motion - I](#)

[Lecture 37 - Brownian motion - II](#)

[Lecture 38 - Brownian motion - III](#)

[Lecture 39 - Brownian motion - IV](#)

[Lecture 40 - Brownian motion - V](#)

[Lecture 41 - Rouse Model - I](#)

[Lecture 42 - Rouse Model - II](#)

[Lecture 43 - Rouse Model - III](#)

[Lecture 44 - Rouse Model - IV](#)

[Lecture 45 - Problems in Rouse Model, Hydrodynamic Interactions](#)

[Lecture 46 - Zimm Model - I](#)

[Lecture 47 - Zimm Model - II](#)

[Lecture 48 - Continuum Mechanics - I](#)

[Lecture 49 - Continuum Mechanics - II](#)

[Lecture 50 - Kuhn's Theory of Rubber Elasticity](#)

[Lecture 51 - Elasticity of polymer network](#)

[Lecture 52 - Microscopic definition of stress tensor - I](#)

[Lecture 53 - Microscopic definition of stress tensor - II, Dumbbell model, introduction to Rouse model](#)

[Lecture 54 - Models for entangled polymeric systems - I](#)

[Lecture 55 - Models for entangled polymeric systems - II](#)

[Lecture 56 - Rheology of complex fluids](#)

[Lecture 57 - Rheometers and rheological tests - I](#)

[Lecture 58 - Rheometers and rheological tests - II](#)

[Lecture 59 - Maxwell model - I](#)

[Lecture 60 - Maxwell model - II, Closing notes](#)

Lecture 1 - Introduction

Lecture 2 - Stress and Strain Relationship - 1

Lecture 3 - Stress and Strain Relationship - 2

Lecture 4 - Terminologies

Lecture 5 - Design of shell

Lecture 6 - Design of heads - 1

Lecture 7 - Design of heads - 2

Lecture 8 - Design of heads - 3

Lecture 9 - Compensation for Opening - 1

Lecture 10 - Compensation for Opening - 2

Lecture 11 - L D ratio

Lecture 12 - Design of Flanges - 1.1

Lecture 13 - Design of Flanges - 1.2

Lecture 14 - Design of Flanges - 2.1

Lecture 15 - Design of Flanges - 2.2

Lecture 16 - Design of support - 1

Lecture 17 - Design of support - 2

Lecture 18 - Vessel under external pressure - 1

Lecture 19 - Vessel under external pressure - 2

Lecture 20 - Vessel under very high pressure

Lecture 1 - Safety and Accident Loss Statistics

Lecture 2 - Risk Management and Hazardous Substance Rules

Lecture 3 - Nature of Accident and major disasters

Lecture 4 - Fundamental Principles: Scale up and Runaway Reactions

Lecture 5 - Problems related to Safety and Accident Loss Statistics

Lecture 6 - Toxicology: Introduction, Routes and Exposure

Lecture 7 - Toxicology: Elimination, Responses, Treatment

Lecture 8 - Dose Response Relationship

Lecture 9 - Dose Response and Threshold Dose: Predictive models and Extrapolation

Lecture 10 - Industrial Hygiene: Regulations and Identification

Lecture 11 - Material Safety Data Sheet - I

Lecture 12 - Material Safety Data Sheet - II

Lecture 13 - Industrial Hygiene: Evaluation

Lecture 14 - Noise, vibration and Radiation

Lecture 15 - Industrial Hygiene: Control

Lecture 16 - Problems related to Industrial Hygiene

Lecture 17 - Introduction to Source Models

Lecture 18 - Source Models for Gas

Lecture 19 - Source Models for Pool Boiling

Lecture 20 - Source Model Problems

Lecture 21 - Fire and Explosions: Introduction

Lecture 22 - Fire and Explosions: Flammability Characteristics

Lecture 23 - Explosion and its Classification - I

Lecture 24 - Explosion and its Classification - II

Lecture 25 - Fire Extinguishers - I

Lecture 26 - Fire Extinguishers - II

Lecture 27 - Problems related to Fire and Explosion

Lecture 28 - Designs to prevent Fire and Explosion: Inerting and Purging

Lecture 29 - Designs to prevent Fire and Explosion: Static Electricity

Lecture 30 - General Design Methods to prevent Fire

Lecture 31 - Sprinklers - I

- [Lecture 32 - Sprinklers - II](#)
- [Lecture 33 - Introduction to Reliefs](#)
- [Lecture 34 - Type of Reliefs](#)
- [Lecture 35 - Relief Scenario](#)
- [Lecture 36 - Relief Sizing](#)
- [Lecture 37 - Hazard and Hazard Identification: Introduction](#)
- [Lecture 38 - Hazard Identification Methods and HAZOP](#)
- [Lecture 39 - Safety Reviews and Risk Assessment - I](#)
- [Lecture 40 - Risk Assessment - II](#)
- [Lecture 41 - Review of Probability Theory](#)
- [Lecture 42 - Event Trees: Quantitative Risk Analysis](#)
- [Lecture 43 - Fault Trees: Quantitative Risk Analysis](#)
- [Lecture 44 - Cause Consequence Analysis and Layer of Protection Analysis](#)
- [Lecture 45 - Bow-Tie Analysis](#)
- [Lecture 46 - Accident Research: Introduction](#)
- [Lecture 47 - Accident Causation Theories](#)
- [Lecture 48 - Accident Investigation Procedure - I](#)
- [Lecture 49 - Accident Investigation Procedure - II](#)
- [Lecture 50 - Jaipur Terminal Fire, India: October 29, 2009](#)
- [Lecture 51 - The Flixborough UK, Cyclohexane Disaster: June 01, 1974](#)
- [Lecture 52 - Seveso Accident: July 10, 1976](#)
- [Lecture 53 - The Chernobyl Nuclear Disaster: April 26, 1986](#)
- [Lecture 54 - Bhopal Gas Tragedy: December 03, 1984](#)
- [Lecture 55 - Bhopal Gas Tragedy: Investigation](#)
- [Lecture 56 - Nuclear Radiation](#)
- [Lecture 57 - Process Safety Management](#)
- [Lecture 58 - Personal Protective Equipments](#)
- [Lecture 59 - Safety: Laws and Regulations](#)
- [Lecture 60 - Nuclear Disaster: Earthquake](#)



Lecture 1 - Introduction

Lecture 2 - Coal as a Source of Energy

Lecture 3 - Characterization of Coal

Lecture 4 - Conventional Route for Energy Production from Coal

Lecture 5 - Tutorial 1

Lecture 6 - Cleaner Route for Energy Production from Coal

Lecture 7 - Gasification of Coal - 1

Lecture 8 - Gasification of Coal - 2

Lecture 9 - Direct Liquefaction of Coal

Lecture 10 - Tutorial 2

Lecture 11 - Petroleum as a Source of Energy

Lecture 12 - Characteristics of Crude Oil and Petroleum Products

Lecture 13 - Refining of Crude Oil for Liquid Fuels Production

Lecture 14 - Conversion of Intermediate Products

Lecture 15 - Tutorial 3

Lecture 16 - Impurities Removal from Liquid Fuels

Lecture 17 - Residue Upgradation - 1

Lecture 18 - Residue Upgradation - 2

Lecture 19 - Heavy Crude Oil Processing

Lecture 20 - Tutorial 4

Lecture 21 - Properties and Routes for Energy Production

Lecture 22 - Syn Gas Production from Natural Gas

Lecture 23 - Syn Gas to Liquid Fuel Production

Lecture 24 - Hydrogen Production from Natural Gas

Lecture 25 - Tutorial 5

Lecture 26 - Solar Energy - 1

Lecture 27 - Solar Energy - 2

Lecture 28 - Wind Energy - 1

Lecture 29 - Wind Energy - 2

Lecture 30 - Tutorial 6

Lecture 31 - Hydro Energy - 1

[Lecture 32 - Hydro Energy - 2](#)

[Lecture 33 - Geothermal Energy](#)

[Lecture 34 - Tidal Energy](#)

[Lecture 35 - Tutorial 7](#)

[Lecture 36 - Energy from Biomass and Wastes 1 \(Biological Route\)](#)

[Lecture 37 - Energy from Biomass and Wastes 2 \(Chemical Route\)](#)

[Lecture 38 - Energy from Biomass and Wastes 3 \(Physical Route\)](#)

[Lecture 39 - Energy Conversations](#)

[Lecture 40 - Tutorial 8](#)

Lecture 1 - Introduction to Polymerization Process - I

Lecture 2 - Introduction to polymerization process - II

Lecture 3 - A Short History of polymerization process, monomers and its distribution

Lecture 4 - Gradient and graft copolymer, polymer and its compositions, isomerism in polymers - I

Lecture 5 - Gradient and graft copolymer, polymer and its compositions, isomerism in polymers - II

Lecture 6 - Bonding forces in polymers

Lecture 7 - Molecular weight and its distribution

Lecture 8 - Control on Polymer Synthesis - I

Lecture 9 - Control on Polymer Synthesis - II

Lecture 10 - Control on Polymer Synthesis - III

Lecture 11 - Morphology of polymers

Lecture 12 - Introduction to reactor design - I

Lecture 13 - Introduction to reactor design - II

Lecture 14 - Temperature dependent term and Interpretation of batch reactor data - I

Lecture 15 - Temperature dependent term and Interpretation of batch reactor data - II

Lecture 16 - Interpretation of batch reactor data - III

Lecture 17 - Interpretation of batch reactor data - IV

Lecture 18 - Design equation for ideal reactors

Lecture 19 - Design Equation for Single Reaction System

Lecture 20 - Multiple reactor system

Lecture 21 - Recycle reactor and autocatalytic reaction

Lecture 22 - Multiple reactions system - I

Lecture 23 - Multiple reactions system - II

Lecture 24 - Multiple reactions system - III

Lecture 25 - Problem Solving - I

Lecture 26 - Problem Solving - II

Lecture 27 - Problem Solving - III

Lecture 28 - Step-growth polymerization - I

Lecture 29 - Step Growth Polymerization - II

Lecture 30 - Step Growth Polymerization - III

Lecture 31 - Step Growth Polymerization - IV

- Lecture 32 - Radical Chain Polymerization Introduction
- Lecture 33 - Radical Chain Polymerization Comparison with Ionic Chain Polymerization
- Lecture 34 - Radical Chain Polymerization Mode of Propagation
- Lecture 35 - Radical Chain Polymerization Rate of Polymerization
- Lecture 36 - Radical Chain Polymerization Rate Expression
- Lecture 37 - Radical Chain Polymerization Process Analysis - I
- Lecture 38 - Radical Chain Polymerization Process Analysis - II
- Lecture 39 - Radical Chain Polymerization Half-life, Propagation and Termination - I
- Lecture 40 - Radical Chain Polymerization Half-life, Propagation and Termination - II
- Lecture 41 - Radical Chain Polymerization Redox Initiation
- Lecture 42 - Radical Chain Polymerization Photochemical and Ionization Initiation
- Lecture 43 - Radical Chain Polymerization Other Initiation Techniques - I
- Lecture 44 - Radical Chain Polymerization Other Initiation Techniques - II
- Lecture 45 - Heterogeneous Polymerization Introduction - I
- Lecture 46 - Heterogeneous Polymerization Introduction - II
- Lecture 47 - Population Balance Modeling Other Techniques - I
- Lecture 48 - Population Balance Modeling Other Techniques - II
- Lecture 49 - Emulsion Polymerization Batch Polymerization
- Lecture 50 - Emulsion Polymerization Semi-continuous polymerization
- Lecture 51 - Emulsion Polymerization Nucleation, Morphology and Reactor Types - I
- Lecture 52 - Emulsion Polymerization Nucleation, Morphology and Reactor Types - II
- Lecture 53 - Emulsion Polymerization PSD and Implementation of the Process - I
- Lecture 54 - Emulsion Polymerization PSD and Implementation of the Process - II
- Lecture 55 - Living and dormant Polymerization
- Lecture 56 - Ionic Polymerization - I
- Lecture 57 - Ionic Polymerization - II
- Lecture 58 - Ionic Polymerization - III
- Lecture 59 - Ionic Polymerization - IV
- Lecture 60 - Ionic Polymerization - V

Lecture 1 - Introduction

Lecture 2 - Classification of exchangers - 1

Lecture 3 - Classification of exchangers - 2

Lecture 4 - Basic Design Parameters - 1

Lecture 5 - Basic Design Parameters - 2

Lecture 6 - Double Pipe Heat Exchanger - 1

Lecture 7 - Double Pipe Heat Exchanger - 2

Lecture 8 - Double Pipe Heat Exchanger - 3

Lecture 9 - Types of Shell and Tube exchangers

Lecture 10 - Exchanger Tubes

Lecture 11 - Exchanger Shell

Lecture 12 - STE design - Kern's method - 1

Lecture 13 - STE design - Kern's method - 2

Lecture 14 - STE design - Kern's method - 3

Lecture 15 - STE design - Kern's method: Example - 4

Lecture 16 - STE design - Kern's method: Example - 5

Lecture 17 - STE design - Bell's method - 1

Lecture 18 - STE design - Bell's method - 2

Lecture 19 - STE design - Bell's method - 3

Lecture 20 - STE design - Bell's method: Example - 4

Lecture 21 - STE design - Bell's method: Example - 5

Lecture 22 - Design of Condenser - 1

Lecture 23 - Design of Condenser - 2

Lecture 24 - Design of Condenser - 3

Lecture 25 - Design of Condenser - 4

Lecture 26 - Design of Condenser - 5

Lecture 27 - Design of Reboiler - 1

Lecture 28 - Design of Reboiler - 2

Lecture 29 - Design of Reboiler - 3

Lecture 30 - Design of Reboiler - 4

Lecture 31 - Design of Reboiler - 5

[Lecture 32 - Design of Reboiler - 6](#)  
[Lecture 33 - Design of Reboiler - 7](#)  
[Lecture 34 - Design of Evaporator - 1](#)  
[Lecture 35 - Design of Evaporator - 2](#)  
[Lecture 36 - Design of Evaporator - 3](#)  
[Lecture 37 - Design of Evaporator - 4](#)  
[Lecture 38 - Design of Evaporator - 5](#)  
[Lecture 39 - Design of Crystallizer - 1](#)  
[Lecture 40 - Design of Crystallizer - 2](#)  
[Lecture 41 - Design of Crystallizer - Examples](#)  
[Lecture 42 - Design of Crystallizer - Types](#)  
[Lecture 43 - Design of Packed Column - 1](#)  
[Lecture 44 - Design of Packed Column - 2](#)  
[Lecture 45 - Design of Packed Column - 3](#)  
[Lecture 46 - Design of Packed Column - 4](#)  
[Lecture 47 - Design of Packed Column - 5](#)  
[Lecture 48 - Distillation Column - 1](#)  
[Lecture 49 - Distillation Column - 2](#)  
[Lecture 50 - Distillation Column - 3](#)  
[Lecture 51 - Distillation Column - 4](#)  
[Lecture 52 - Distillation Column - 5](#)  
[Lecture 53 - Distillation Column - 6](#)  
[Lecture 54 - Distillation Column - 7](#)  
[Lecture 55 - Distillation Column - 8](#)  
[Lecture 56 - Distillation Column - Mechanical Design - 1](#)  
[Lecture 57 - Distillation Column - Mechanical Design - 2](#)  
[Lecture 58 - Distillation Column - Mechanical Design - 3](#)  
[Lecture 59 - Distillation Column - Mechanical Design - 4](#)  
[Lecture 60 - Distillation Column - Mechanical Design - 5](#)

Lecture 1 - Introduction to the course

Lecture 2 - Molecular basis of energy and entropy

Lecture 3 - Probability and probability distributions

Lecture 4 - Probability distributions and thermodynamic equilibrium

Lecture 5 - Energy distribution in molecular systems

Lecture 6 - First and second law of thermodynamics

Lecture 7 - Reversible and irreversible processes; third law of thermodynamics; legendre transformation; thermodynamic functions for one component system

Lecture 8 - Thermodynamic functions for multi-component systems; chemical potential; why do we minimize thermodynamic functions?

Lecture 9 - Extensive and intensive variables; gibbs duhem relation; euler theorem; maxwell relations

Lecture 10 - Discrete and continuous probabilities; stirling approximation

Lecture 11 - Binomial distribution approaches Gaussian distribution for large n; definition of drunkard walk

Lecture 12 - Solution of drunkard walk; Lagrange multipliers

Lecture 13 - Energy distribution in molecular system revisited; introduction to thermodynamic ensembles

Lecture 14 - Canonical ensemble: most probable distribution, partition function

Lecture 15 - Definition of temperature; third law of thermodynamics

Lecture 16 - Canonical ensemble: Helmholtz free energy, averages and fluctuations, specific heat, deriving ideal gas law

Lecture 17 - Partition function of a dense gas; grand canonical ensemble: partition function, most probable distribution

Lecture 18 - Computing properties in grand canonical ensemble

Lecture 19 - Isothermal isobaric ensemble

Lecture 20 - Summary of thermodynamic ensembles; partition function of an ideal gas

Lecture 21 - Mixing and phase separation, phase equilibrium of a multiphase multicomponent system, Gibbs phase rule

Lecture 22 - Pure component phase diagram; solution thermodynamics: Helmholtz free energy density

Lecture 23 - Characterizing mixing and phase separation using Helmholtz free energy density

Lecture 24 - Common tangent construction, definition of binodal, spinodal, and critical point

Lecture 25 - Osmotic pressure and chemical potential

Lecture 26 - Lattice model of liquid solutions - I

Lecture 27 - Lattice model of liquid solutions - II

Lecture 28 - Lattice model of liquid solutions - III

Lecture 29 - Critical review of Lattice model, theoretical basis of molecular dynamics simulation

Lecture 30 - Theoretical basis of molecular dynamics simulation

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Lecture 31 - Interaction energy and force field

Lecture 32 - Liouville theorem; theoretical basis of Monte Carlo simulation

Lecture 33 - Introduction to Monte Carlo simulation method

Lecture 34 - Markov chain algorithm, condition for equilibrium and detailed balance

Lecture 35 - Metropolis algorithm, periodic boundary condition

Lecture 36 - Numerical implementation of Monte Carlo simulation: Python Examples - I

Lecture 37 - Numerical implementation of Monte Carlo simulation: Python Examples - II

Lecture 38 - Numerical implementation of Monte Carlo simulation: Python Examples - III

Lecture 39 - Numerical implementation of Monte Carlo simulation: Python Examples - IV

Lecture 40 - Numerical implementation of Monte Carlo simulation: Python Examples - V

Lecture 41 - Particle simulations: comparison with quantum chemical and continuum simulations; bridging length and time scales

Lecture 42 - Pair potentials

Lecture 43 - Saving CPU time: short range and long range interactions

Lecture 44 - Bonded and non-bonded interactions, force fields

Lecture 45 - Practical aspects of molecular simulations

Lecture 46 - Numerical implementation of MD; thermostat and barostat

Lecture 47 - MD simulations - efficiency and parallelization, sampling and averaging, analysis of simulation trajectories

Lecture 48 - MD simulations - analysis of simulation trajectories (continued), Case Studies - I

Lecture 49 - MD simulations - Case Studies - II

Lecture 50 - MD simulations - Case Studies - III

Lecture 51 - Free energies and phase behavior; extension of canonical ensemble Monte Carlo to other ensembles

Lecture 52 - Extension of canonical ensemble Monte Carlo to other ensembles (Continued...)

Lecture 53 - Monte Carlo in Gibbs ensemble and semi-grand canonical ensemble, thermodynamic integration

Lecture 54 - Thermodynamic integration (continued); Widom's particle insertion; overlapping distribution method

Lecture 55 - Multiple histogram method; umbrella sampling; thermodynamic cycle; potential of mean force; pulling simulations; metadynamics; tackling time scale issues

Lecture 56 - Tackling time scale issues (continued); nonequilibrium molecular dynamics; mesoscale simulations: Langevin dynamics and Brownian dynamics, kinetic Monte Carlo simulations; dissipative particle dynamics

Lecture 57 - Multiparticle collision dynamics; lattice Boltzmann method; coarse-graining

Lecture 58 - Case studies

Lecture 59 - Simulations of chemical reactions using Kinetic Monte Carlo simulations

Lecture 60 - Reactive force fields; Ab initio molecular dynamics and other advanced methods; molecular simulations in chemical engineering; concluding remarks



Lecture 1 - Introduction to Chemical Process Utilities

Lecture 2 - Energy Perspective to the Utilities

Lecture 3 - Power Cycle

Lecture 4 - Fuel Analysis

Lecture 5 - Practice problems related to power cycle and fuel analysis

Lecture 6 - Heat Transfer Utilities - I

Lecture 7 - Heat Transfer Utilities - II

Lecture 8 - Plate and Frame Heat Exchangers Types

Lecture 9 - Solar Energy - I

Lecture 10 - Solar Energy - II

Lecture 11 - Heat Transfer Media and Solar energy

Lecture 12 - Water

Lecture 13 - Water Chemistry

Lecture 14 - Inhibition and Water Treatment

Lecture 15 - Boiler Water treatment

Lecture 16 - Water Governance

Lecture 17 - Water Quality standards - I

Lecture 18 - Water Quality Standards - II

Lecture 19 - Steam

Lecture 20 - Boilers

Lecture 21 - Industrial Boiler Types

Lecture 22 - Boilers

Lecture 23 - Boilers- Question Practice

Lecture 24 - Steam Generation Unit

Lecture 25 - Steam Generation Unit-Heaters

Lecture 26 - Attemperator and Steam Drum

Lecture 27 - Steam Traps, Centralization, and Fuel Selection

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Lecture 25 - Unidirectional transport: Separation of variables for transport in a finite domain

Lecture 26 - Unidirectional transport: Separation of variables for transport in a finite domain (Continued...)

Lecture 27 - Unidirectional transport: Separation of variables for transport in a finite domain (Continued...)

Lecture 28 - Unidirectional transport: Separation of variables for transport in a finite domain (Continued...)

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