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**Co-ordinators : Prof. Ganesh A. Viswanathan**

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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

Lecture 1 - Why Computational Chemistry

Lecture 2 - Revisiting Quantum Mechanics - I

Lecture 3 - Revisiting Quantum Mechanics - II

Lecture 4 - Introduction to ORCA, Quantum Chemistry Package

Lecture 5 - The Hartree-Fock Approximation

Lecture 6 - Introduction to GUI - I

Lecture 7 - Introduction to GUI - II

Lecture 8 - Introduction to GUI - III

Lecture 9 - Open-Shell Systems - I

Lecture 10 - Open-Shell Systems - II

Lecture 11 - Open-Shell Systems - III

Lecture 12 - Solving Homework Problems of HF

Lecture 13 - Solving Homework Problems of Open-Shell

Lecture 14 - Introduction to Basis set - I

Lecture 15 - Introduction to Basis set - II

Lecture 16 - Introduction to Basis set - III

Lecture 17 - Basis Set Superposition Error and Counterpoise Correction

Lecture 18 - Introduction to Electron Correlation

Lecture 19 - MÅller Plesset Perturbation Theory

Lecture 20 - Configuration Interaction

Lecture 21 - Coupled Cluster Theory

Lecture 22 - Solving Homework Problems of MP2

Lecture 23 - Solving Homework Problems of Coupled Cluster

Lecture 24 - Lower Scaling Approximation - I (Density Fitting and Chain of Sphere)

Lecture 25 - Lower Scaling Approximation - II (Local Orbital and Natural Orbital)

Lecture 26 - Complete Basis Set Extrapolation

Lecture 27 - Exact Density Functional Theory - I

Lecture 28 - Exact Density Functional Theory - II

Lecture 29 - Practical Density Functional Theory - I

Lecture 30 - Practical Density Functional Theory - II

Lecture 31 - Hybrid Density Functional Theory - I

Lecture 32 - Hybrid Density Functional Theory - II  
Lecture 33 - Hybrid Density Functional Theory - III  
Lecture 34 - Hybrid Density Functional Theory - IV  
Lecture 35 - Homework Problem of DFT  
Lecture 36 - Potential Energy Surface - I  
Lecture 37 - Potential Energy Surface - II  
Lecture 38 - Potential Energy Surface - III  
Lecture 39 - IR and Raman Spectroscopy - I  
Lecture 40 - IR and Raman Spectroscopy - II  
Lecture 41 - Homework problem of Potential Energy Surface  
Lecture 42 - Thermochemistry - I  
Lecture 43 - Thermochemistry - II  
Lecture 44 - Thermochemistry - III  
Lecture 45 - Transition state search - I  
Lecture 46 - Transition state search - II  
Lecture 47 - Transition state search - III  
Lecture 48 - Transition state search - IV  
Lecture 49 - Homework problem of Transition State Search  
Lecture 50 - Multi-layer Modelling - Molecular Mechanics  
Lecture 51 - QM/MM - I  
Lecture 52 - QM/MM - II  
Lecture 53 - QM/MM - III  
Lecture 54 - QM/MM - IV  
Lecture 55 - QM/MM - V  
Lecture 56 - Homework problem of QM/MM  
Lecture 57 - Excited state methods - CIS and TDDFT  
Lecture 58 - Excited state methods (Continued...)  
Lecture 59 - Excited state method - EOMCCSD  
Lecture 60 - Charge transfer excitation  
Lecture 61 - X-Ray Spectroscopy  
Lecture 62 - Homework problem of Excited State Spectra  
Lecture 63 - Solvation models - I  
Lecture 64 - Solvation models - II



[Lecture 65 - Solvation models - III](#)

[Lecture 66 - Explicit solvation - I](#)

[Lecture 67 - Explicit solvation - II](#)

[Lecture 68 - Additional Homework Problem of Week 7](#)

[Lecture 69 - NMR](#)

[Lecture 70 - Relativistic Quantum Chemistry](#)

[Lecture 71 - CASSCF - I](#)

[Lecture 72 - CASSCF - II](#)

[Lecture 73 - CASSCF - III](#)

**NPTEL : Heterogeneous Catalysis and Catalytic Processes (Chemical Engineering)**

**Co-ordinators : Dr. K.K. Pant**

[Lecture 1](#)

[Lecture 2](#)

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[Lecture 40](#)

**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 - Colloida, Aerosols, Emulsions Foams, Coagulation Smoluchowski's Theory

[Lecture 1 \(1\)](#)

[Lecture 2 \(1A\)](#)

[Lecture 3 \(2\)](#)

[Lecture 4 \(2A\)](#)

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

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

[Lecture 7 \(4\)](#)

[Lecture 8 \(4A\)](#)

[Lecture 9 \(5\)](#)

[Lecture 10 \(5A\)](#)

[Lecture 11 \(6\)](#)

[Lecture 12 \(6A\)](#)

[Lecture 13 \(7\)](#)

[Lecture 14 \(7A\)](#)

[Lecture 15 \(8\)](#)

[Lecture 16 \(8A\)](#)

[Lecture 17 \(8B\)](#)

[Lecture 18 \(9\)](#)

[Lecture 19 \(9A\)](#)

[Lecture 20 \(10\)](#)

[Lecture 21 \(10A\)](#)

[Lecture 22 \(10B\)](#)

[Lecture 23 \(11\)](#)

[Lecture 24 \(12\)](#)

[Lecture 25 \(12A\)](#)

[Lecture 26 \(12B\)](#)

[Lecture 27 \(13\)](#)

[Lecture 28 \(13A\)](#)

[Lecture 29 \(14\)](#)

[Lecture 30 \(14A\)](#)

[Lecture 31 \(15\)](#)

[Lecture 32 \(15A\)](#)

[Lecture 33 \(16\)](#)

[Lecture 34 \(16A\)](#)

[Lecture 35 \(17\)](#)

[Lecture 36 \(17A\)](#)

[Lecture 37 \(18\)](#)

[Lecture 38 \(18A\)](#)

[Lecture 39 \(19\)](#)

[Lecture 40 \(19A\)](#)

[Lecture 41 \(20\)](#)

[Lecture 42 \(20A\)](#)

[Lecture 43 \(20B\)](#)

[Lecture 44 \(21\)](#)

[Lecture 45 \(21A\)](#)

[Lecture 46 \(22\)](#)

[Lecture 47 \(22A\)](#)

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[Lecture 59 \(28A\)](#)

[Lecture 60 \(29\)](#)

[Lecture 61 \(29A\)](#)

[Lecture 62 \(30\)](#)

[Lecture 63 \(30A\)](#)

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

Lecture 65 (31A)



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 coefficient 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

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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)

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Lecture 6 - Nodal Analysis

Lecture 7 - Inflow Performance Relationship (IPR) - I

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Lecture 9 - Gas Well Testing

Lecture 10 - Wellbore Performance Relationship (WPR)

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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

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Lecture 19 - Transportation of Natural Gas - I

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Lecture 21 - Unconventional production of Natural Gas

Lecture 22 - Review: Concluding Remarks

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Lecture 2 - First law for closed systems

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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

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Lecture 27 - Calculation of Fugacity using EoS - Part 2

Lecture 28 - Calculation of Fugacity in Mixtures using Cubic EoS

Lecture 29 - Fugacity in Liquids, Activity Coefficient

Lecture 30 - Models for Excess Gibbs free energy - Part 1

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[Lecture 34 - Azeotropes](#)

[Lecture 35 - Gamma/Phi Formulation](#)

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- Lecture 1 - Introduction and Overview of Mass Transfer Operation
- Lecture 2 - Molecular and Eddy Diffusion, Diffusion Velocities and Fluxes
- Lecture 3 - Fick's First and Second Law
- Lecture 4 - Steady State Molecular Diffusion in fluids under stagnant and laminar flow conditions
- Lecture 5 - Diffusion through variable cross-sectional area
- Lecture 6 - Gas Phase Diffusion Coefficient measurement
- Lecture 7 - Gas Phase Diffusion Coefficient prediction and liquid phase diffusion coefficient measurement and prediction
- Lecture 8 - Multicomponent diffusion and diffusivity in solids
- Lecture 9 - Mass transfer coefficient concept and classifications
- Lecture 10 - Dimensionless groups and correlations for convective mass transfer coefficients
- Lecture 11 - Mass transfer coefficient in laminar flow
- Lecture 12 - Boundary Layer Theory and mass transfer coefficients in turbulent flow
- Lecture 13 - Mass transfer theories
- Lecture 14 - Interphase mass transfer
- Lecture 15 - Interphase mass transfer and material balance for operating line
- Lecture 16 - Number of ideal stages in counter current operation: graphical and algebraic methods
- Lecture 17 - Introduction, classification, Sparged and agitated vessels design
- Lecture 18 - Gas dispersed: Tray tower
- Lecture 19 - Sieve Tray
- Lecture 20 - Liquid dispersed: Venture scrubber, wetted wall column, Packed tower
- Lecture 21 - Introduction to absorption, Equilibrium in gas-liquid system, and minimum liquid rate
- Lecture 22 - Design of packed column absorber based on the Individual Mass Transfer Coefficient
- Lecture 23 - Design of packed column absorber based on the Overall Mass Transfer Coefficient
- Lecture 24 - Height Equivalent to a Theoretical Plate (HETP), Design of packed column absorber for dilute and concentrated gases
- Lecture 25 - Absorption in plate column: Method of McCabe and Thiele-graphical determination of ideal trays and Introduction to multicomponent absorption
- Lecture 26 - Introduction to distillation, binary equilibrium diagrams and concept of relative volatility
- Lecture 27 - Distillation in non-ideal systems and concept of enthalpy-concentration diagram
- Lecture 28 - Flash distillation
- Lecture 29 - Batch and steam distillation
- Lecture 30 - Continuous multistate fractionation

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

- Lecture 31 - Number of trays by McCabe and Thiele for distillation
- Lecture 32 - Pinch Points and minimum reflux
- Lecture 33 - Reflux below its bubble point: Sub-cooled reflux and use of open steam
- Lecture 34 - Multiple feeds, multiple product withdrawal or side streams
- Lecture 35 - Multistage batch distillation with reflux
- Lecture 36 - The Ponchon-Savarit method
- Lecture 37 - The Ponchon-Savarit method
- Lecture 38 - Packed Distillation
- Lecture 39 - Introduction to multicomponent distillation and multicomponent flash distillation
- Lecture 40 - Minimum stages and minimum reflux in multicomponent distillation
- Lecture 41 - Multicomponent batch distillation

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Lecture 2 - Classification of Non-Newtonian Fluids

Lecture 3 - Mathematical Models for Non-Newtonian Fluids

Lecture 4 - Viscoelastic Non-Newtonian Fluids

Lecture 5 - Capillary Viscometers: Sources of Errors and Correction Methods

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Lecture 7 - Capillary Viscometers - Errors and Corrections II

Lecture 8 - Equation of Change for Non-Isothermal Systems

Lecture 9 - Rotational Viscometers - II

Lecture 10 - Rotational Viscometers - III

Lecture 11 - Transition from Laminar to Turbulent Flow in Pipes for GNF

Lecture 12 - Equations of Change for Isothermal Systems

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Lecture 16 - Bingham Plastic Fluids Flow through Pipes

Lecture 17 - Herschel Bulkley Fluids Flow through Pipes

Lecture 18 - Transition and Turbulent Flow of GNF in Pipes - I

Lecture 19 - Transition and Turbulent Flow of GNF in Pipes - II

Lecture 20 - Laminar flow of GNFs between Parallel Plates and along Inclined Surface

Lecture 21 - Laminar flow of GNFs along Inclined Surface and Concentric Annulus

Lecture 22 - Flow of Non-Newtonian Fluids through Packed Beds

Lecture 23 - Dispersion in Packed Beds: Non-Newtonian Effects

Lecture 24 - Liquid-Solid Fluidization by Power-law Liquids

Lecture 25 - Free Convection between Two Vertical Plates

Lecture 26 - Viscous Heat Generation

Lecture 27 - Temperature distribution in fluids confined between co-axial cylinders

Lecture 28 - Temperature distribution for FDF of Newtonian fluids in tubes

Lecture 29 - Heat Transfer Combined with Chemical Reactions

Lecture 30 - Transpiration Cooling

Lecture 31 - Basics of MT; Diffusion Through Stagnant Gas Film

[Lecture 32 - Non-Isothermal Diffusive MT and Forced Convective MT](#)

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[Lecture 40 - Momentum Boundary Layer Thickness of Non-Newtonian Fluids](#)

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Lecture 2 - Characteristics of fluid (Continued...)

Lecture 3 - Fluid Statics

Lecture 4 - Fluid Statics (Continued...)

Lecture 5 - Fundamentals of flow - Part 1

Lecture 6 - Fundamentals of flow - Part 2

Lecture 7 - One dimensional flow - Part 1

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Lecture 10 - Flow of Viscous fluid - Introduction

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Lecture 14 - Theory of lubrication

Lecture 15 - Frictional resistance

Lecture 16 - Losses in geometric change

Lecture 17 - Losses in geometric change (Continued...)

Lecture 18 - Flow Velocity and Optimum Shape

Lecture 19 - Equation of Energy and Discharge of Water Channel

Lecture 20 - Drag

Lecture 21 - Lift and Cavitation

Lecture 22 - Dimensional Analysis

Lecture 23 - Dimensional Analysis: Buckingham's  $\pi$  Theorem

Lecture 24 - Law of Similarity and Significant Dimensionless Number

Lecture 25 - Compressible Flow - Part 1

Lecture 26 - Compressible Flow - Part 2

Lecture 27 - Measurement of Flow - Part 1

Lecture 28 - Measurement of Flow - Part 2

Lecture 29 - Measurement of Flow - Part 3

Lecture 30 - Introduction to multiphase flow

Lecture 31 - Hydrodynamics in multiphase flow

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Lecture 1 - History, Philosophy and Concept

Lecture 2 - Principle Features

Lecture 3 - Strategies and domain based techniques

Lecture 4 - Intensification by fluid flow process

Lecture 5 - Mechanism of Intensification by mixing

Lecture 6 - Intensification in Reactive system

Lecture 7 - Problems leading to sustainable development

Lecture 8 - Concept, Issues and Challenges

Lecture 9 - Strategies in process design

Lecture 10 - Scales and stages of process intensification

Lecture 11 - Methods and Tools for Achieving sustainable design

Lecture 12 - Multi-level Computer aided tools

Lecture 13 - Introduction on Stochastic Optimization

Lecture 14 - Optimization Algorithms

Lecture 15 - Applications of Optimization Algorithms

Lecture 16 - Introduction and Mechanism of Cavitation-based PI

Lecture 17 - Cavitation Reactor Configurations and activity

Lecture 18 - Parametric effects on cavitation

Lecture 19 - Introduction of monolith reactor

Lecture 20 - Preparation of monolithic catalyst

Lecture 21 - Application of monolithic catalyst

Lecture 22 - Hydrodynamics, transport of monolithic reactor

Lecture 23 - Overview of interfacial area based processes

Lecture 24 - Ejector induced downflow system for PI

Lecture 25 - Hydrodynamics and transport in downflow system

Lecture 26 - Introduction and Principles

Lecture 27 - Types of Intensified Distillation Units

Lecture 28 - Design of membrane-assisted distillation

Lecture 29 - Introduction and Principles

Lecture 30 - Supercritical extraction for process intensification

Lecture 31 - Introduction to membrane and its principles



[Lecture 32 - Membrane engineering in process intensification](#)

[Lecture 33 - Introduction to microprocess technology](#)

[Lecture 34 - Process Intensification by Microreactors](#)

[Lecture 35 - Hydrodynamics and transport in microchannel based microreactor](#)

- Lecture 1 - Introduction and Overview on Reaction Engineering
- Lecture 2 - Kinetics of Homogeneous Reactions
- Lecture 3 - Kinetic Model and Temperature Dependency
- Lecture 4 - Introduction and Stoichiometry for the Batch System
- Lecture 5 - Stoichiometry for Constant Volume Flow and Variable Volume Batch Systems
- Lecture 6 - Stoichiometry for Variable Volume Flow System
- Lecture 7 - Analysis of Batch Reactor Kinetic Data
- Lecture 8 - Intregal Method of Analysis of Batch Reactor Data - Part 1
- Lecture 9 - Intregal Method of Analysis of Batch Reactor Data - Part 2
- Lecture 10 - Differential Method of Analysis and Variable Volume Batch Reactor Data
- Lecture 11 - Introduction and Ideal Batch Reactor Design
- Lecture 12 - Ideal Mixed Flow Reactor Design
- Lecture 13 - Ideal Plug Flow Reactor Design
- Lecture 14 - Size Comparision of Single and Multiple Reactors
- Lecture 15 - Size Comaprison Multiple Reactors
- Lecture 16 - Recycle and Autocatalytic Reactors
- Lecture 17 - Design for Parallel Reactions
- Lecture 18 - Design for Series Reactions
- Lecture 19 - Design for Series-Parallel Reactions
- Lecture 20 - Denbigh Reactions and Their Special Cases
- Lecture 21 - Heats of Reaction and Equilibrium Conversion from Thermodynamics
- Lecture 22 - General Graphical Reactor Design Procedure
- Lecture 23 - Material and Energy Balances in Batch Reactor
- Lecture 24 - Optimum Temperature Progression in Batch Reactor
- Lecture 25 - Material and Energy Balances in Flug Flow and Mixed Flow Reactors
- Lecture 26 - Ideal and Non-Ideal Mixed Flow Reactor Design and Multiple Steady States
- Lecture 27 - Non-Ideal Reactors and Residence Time Distribution
- Lecture 28 - RTD Measurement and Moments of RTD
- Lecture 29 - RTD in Ideal Reactors
- Lecture 30 - Reactor Modeling using the RTD

Lecture 1 - Basic concepts, Adiabatic saturation temperature

Lecture 2 - Design calculations of cooling tower

Lecture 3 - Design of cooling tower

Lecture 4 - Design of cooling tower

Lecture 5 - Air conditioning, Example problems on dehumidification

Lecture 6 - Mechanism of drying and drying equilibria, drying rate curve

Lecture 7 - Drying: rate of drying for batch dryers

Lecture 8 - Drying: rate of drying for continuous dryers

Lecture 9 - Drying time calculation from drying rate curve

Lecture 10 - Introduction to liquid-liquid extraction, liquid-liquid equilibria

Lecture 11 - Effect of temperature on LLE and Design of single stage extraction

Lecture 12 - Design Calculation of Multistage Operation

Lecture 13 - Design calculation of multistage cross-current extraction

Lecture 14 - Design calculation of multistage counter-current extraction, Selection of extractors

Lecture 15 - Leaching: single stage operation

Lecture 16 - Leaching: multistage operation

Lecture 17 - Supercritical Fluid Extraction, equipment for leaching

Lecture 18 - Fundamentals of membrane separation processes

Lecture 19 - Manufacturing of membranes, advantages and limitations

Lecture 20 - Various models and applications: design aspects

Lecture 21 - Various models and applications: design aspects

Lecture 22 - Electric field enhanced membrane separation processes

Lecture 23 - Micellar-enhanced ultrafiltration

Lecture 24 - Adsorption: types and nature, isotherm

Lecture 25 - Stage wise and continuous adsorption

Lecture 26 - Fluidized bed and teeter bed

Lecture 27 - Unsteady state fixed bed adsorbers, ion exchange

Lecture 28 - Crystallization, types of crystal geometry

Lecture 29 - Solid-liquid phase equilibrium, Theory of crystallization

Lecture 30 - Design of crystallizer, crystallization equipment

Lecture 31 - Concluding remarks - Part 1



Lecture 1 - Introduction of Particulate Solids

Lecture 2 - Particle Size

Lecture 3 - Particle Shape and Density

Lecture 4 - Screening

Lecture 5 - Size Analysis by Screening

Lecture 6 - Screening Equipment, Effectiveness and Capacity

Lecture 7 - Methods of Size Reduction

Lecture 8 - Equipment for Size Reduction - Crushers

Lecture 9 - Equipment for Size Reduction - Gridners

Lecture 10 - Equipment for Size Reduction - Ultrafine Grinders and Cutting Machines

Lecture 11 - Storage of Bulk Solids

Lecture 12 - Solids Flow Out and their Flow Patterns

Lecture 13 - Conveying of Bulk Solids

Lecture 14 - Size Enlargement Methods

Lecture 15 - Size Enlargement Equipment - 1

Lecture 16 - Size Enlargement Equipment - 2

Lecture 17 - Flow past Immersed Solid Objects

Lecture 18 - Motion of Particles through Fluids - 1

Lecture 19 - Motion of Particles through Fluids - 2

Lecture 20 - Motion of Particles through Fluids - 3

Lecture 21 - Flow through Beds of Solids - 1

Lecture 22 - Flow through Beds of Solids - 2

Lecture 23 - Flow through Fluidized Beds - 1

Lecture 24 - Flow through Fluidized Beds - 2

Lecture 25 - Filtration

Lecture 26 - Principles of Cake Filtration - 1

Lecture 27 - Principles of Cake Filtration - 2

Lecture 28 - Filtration Equipment

Lecture 29 - Cross Flow Filtration - 1

Lecture 30 - Cross Flow Filtration - 2

Lecture 31 - Gravity Sedimentation - Classifiers

[Lecture 32 - Gravity Sedimentation - Design of Thickeners - 1](#)

[Lecture 33 - Gravity Sedimentation - Design of Thickeners - 2](#)

[Lecture 34 - Centrifugal Separations - 1](#)

[Lecture 35 - Centrifugal Separations - 2](#)

[Lecture 36 - Floatation - 1](#)

[Lecture 37 - Floatation - 2](#)

Lecture 1 - Introduction of Phase Equilibrium

Lecture 2 - Classical Thermodynamics of Phase Equilibria - 1

Lecture 3 - Classical Thermodynamics of Phase Equilibria - 2

Lecture 4 - Thermodynamic Properties from Volumetric Data

Lecture 5 - Fugacity from Volumetric Data - 1

Lecture 6 - Fugacity from Volumetric Data - 2

Lecture 7 - Intermolecular Forces and Non-Ideal Behaviour

Lecture 8 - Intermolecular Forces-Potential Energy Functions

Lecture 9 - Molecular Theory of Corresponding States - 1

Lecture 10 - Molecular Theory of Corresponding States - 2

Lecture 11 - Intermolecular Potential and EoS

Lecture 12 - Virial Coefficients from Potential Functions

Lecture 13 - Virial Coefficients from Corresponding States Theory

Lecture 14 - Fugacities in Gaseous Mixtures - 1

Lecture 15 - Fugacities in Gaseous Mixtures - 2

Lecture 16 - Fugacities in Gaseous Mixtures - 3

Lecture 17 - Liquid Mixtures and Excess Functions

Lecture 18 - Excess Functions and Activity Coefficients

Lecture 19 - Activity Coefficients and Thermodynamic Consistency

Lecture 20 - Models for Excess Gibbs Energy - 1

Lecture 21 - Models for Excess Gibbs Energy - 2

Lecture 22 - Models for Excess Gibbs Energy - 3

Lecture 23 - Vapour-Liquid Equilibrium - 1

Lecture 24 - Vapour-Liquid Equilibrium - 2

Lecture 25 - Vapour-Liquid Equilibrium - 3

Lecture 26 - Liquid-Liquid Equilibrium - 1

Lecture 27 - Liquid-Liquid Equilibrium - 2

Lecture 28 - Vapour-Liquid-Liquid Equilibrium - 1

Lecture 29 - Vapour-Liquid-Liquid Equilibrium - 2

Lecture 30 - Solid-Liquid Equilibrium - 1

Lecture 31 - Solid-Liquid Equilibrium - 2





**NPTEL : NOC:Membrane Technology (Chemical Engineering)**

**Co-ordinators : Prof. Kaustubha Mohanty**

Lecture 1 - Separation Processes, Historical Development, Definition and Types of Membranes

Lecture 2 - Membrane Processes and Classifications, Advantages, Disadvantages, Applications

Lecture 3 - Polymer Basics, Polymers used in Membrane Preparation and their Properties

Lecture 4 - Inorganic Materials for Membrane Preparation, their Advantages and Disadvantages

Lecture 5 - Membrane Modules and Selection, Flow Types

Lecture 6 - Preparation of Synthetic Membrane, Phase Inversion Membranes

Lecture 7 - Composite membranes: Interfacial polymerization, dip-coating, plasma polymerization

Lecture 8 - Inorganic membranes: Sol-Gel process, ceramic membrane preparation, membrane modification

Lecture 9 - Porous and non-porous membranes, characterization of porous membranes and MF membrane

Lecture 10 - MF membrane characterization: Bubble point, Mercury intrusion, Permeability method

Lecture 11 - UF membrane characterization: Gas adsorption-desorption, Thermoporometry, MWCO method

Lecture 12 - Passive transport, active transport, description of transport process

Lecture 13 - Transport through porous membrane and nonporous membrane

Lecture 14 - Concept of osmosis and reverse osmosis, thermodynamic analysis

Lecture 15 - Revision of concepts and fundamentals

Lecture 16 - HP and LP RO, membrane materials, modules, models for RO transport

Lecture 17 - Advantages of RO, fouling, RO applications, Pressure retarded osmosis

Lecture 18 - Nanofiltration basics, transport mechanism, fouling model and applications

Lecture 19 - Basic principles of UF, membranes and modules, UF configurations

Lecture 20 - Models for UF transport, mass transfer coefficient, membrane rejection and sieving coefficient

Lecture 21 - Factors affecting UF performance, fouling and permeate flux enhancement, UF applications I

Lecture 22 - Micellar-enhanced UF, affinity UF, UF based bioseparation

Lecture 23 - Basic principles, advantages of MF, cross-flow and dead-end MF, membranes and modules

Lecture 24 - Models for MF transport, plugging and throughput, fouling in MF, MF applications

Lecture 25 - Problems and solutions based on RO and MF

Lecture 26 - Problems and solutions based on UF

Lecture 27 - Dialysis, membranes and modules, mass transport in dialysis, diffusion analysis, applications

Lecture 28 - Ion-exchange membranes, ED process, energy requirement, applications, reverse ED

Lecture 29 - PV principle, advantages, mass transfer and applications, hybrid distillation/PV

Lecture 30 - Problems and solutions based on ED and PV

Lecture 31 - Concept, types of LM, mechanism of mass transfer in LM, choice of solvent and carrier, applications

Lecture 32 - Basic principle of gas separation, transport mechanism, factors affecting gas separation, applications

Lecture 33 - Basic principle of MD, mechanism, process parameters, membranes, applications

Lecture 34 - Mechanism, coupled transport, carrier agent, active and passive transport, applications

Lecture 35 - Gas-liquid and liquid-liquid contactors, membrane reactors and bioreactors, PEM hydrogen fuel cell

Lecture 36 - Perstraction, membrane chromatography and controlled drug delivery

Lecture 1 - Introduction to Optimization

Lecture 2 - Linear Regression

Lecture 3 - Multiple, Polynomial and General Linear Least Square Regression

Lecture 4 - Nonlinear Regression

Lecture 5 - Regression : MATLAB Implementation

Lecture 6 - Teaching Learning Based Optimization

Lecture 7 - Implementation of TLBO in MATLAB

Lecture 8 - Supplementary: Preliminary Statistical analysis for metaheuristic techniques

Lecture 9 - Supplementary: Preliminary Statistical analysis - MATLAB implementation

Lecture 10 - Particle Swarm Optimization

Lecture 11 - Implementation of Particle Swarm Optimization using MATLAB

Lecture 12 - Differential Evolution

Lecture 13 - Implementation of Differential Evolution using MATLAB

Lecture 14 - Binary Coded Genetic Algorithm

Lecture 15 - Real Coded Genetic Algorithm

Lecture 16 - Implementation of Real Coded Genetic Algorithm using MATLAB

Lecture 17 - Artificial Bee Colony Algorithm

Lecture 18 - Working of Artificial Bee Colony Algorithm

Lecture 19 - Implementation of Artificial Bee Colony using MATLAB

Lecture 20 - Comparison of Variation Operators and Survival Strategies

Lecture 21 - Black-Box Optimization Problems

Lecture 22 - Constraint-Handling in Metaheuristic Techniques

Lecture 23 - Case Study: Production planning

Lecture 24 - Case Study: Production planning MATLAB Implementation

Lecture 25 - Parallelization and Vectorization of Fitness Function

Lecture 26 - Constraint-Handling using Correction Approach

Lecture 27 - MATLAB inbuilt functions: Linear and Mixed Integer Linear Programming

Lecture 28 - MATLAB inbuilt functions: Nonlinear and Mixed Integer Nonlinear Programming

Lecture 29 - MATLAB Optimization Tool: Options, Output Function, Vectorization, Parallelization

Lecture 30 - MATLAB inbuilt functions: Multi-objective Optimization

Lecture 31 - Simplex Method for LP

[Lecture 32 - Branch and Bound Method for MILP](#)

[Lecture 33 - MILP formulation of Production Planning Problem](#)

[Lecture 34 - Generalized Algebraic Modelling System](#)

[Lecture 35 - Solution of Production Planning Problem using GAMS and NEOS, MIRO](#)

[Lecture 36 - IBM ILOG CPLEX Optimization Studio](#)

[Lecture 37 - Constraint Programming Applications in IBM ILOG CPLEX Optimization Studio](#)

- Lecture 1 - Definition, History, Role of Chemical Engineer
- Lecture 2 - Basic Features of Chemical Process
- Lecture 3 - Unit systems and dimensions
- Lecture 4 - Variables and Properties of Material in System
- Lecture 5 - Pressure and Temperature of Flow Process
- Lecture 6 - Rate of Process
- Lecture 7 - Principles of material balance and calculation
- Lecture 8 - Material Balances on Processes with Recycle and Bypass
- Lecture 9 - Material balances on reactive processes
- Lecture 10 - Material balances on combustion reactions
- Lecture 11 - State Equation of Ideal Gas and Calculation
- Lecture 12 - State Equation of non-Ideal Gas and Calculation
- Lecture 13 - Phase equilibrium
- Lecture 14 - Equilibrium Laws, Humidity and Saturation
- Lecture 15 - Humidity, Saturation Psychrometric chart
- Lecture 16 - Process of phase change: Condensation and vaporization
- Lecture 17 - Principles of Energy
- Lecture 18 - Laws and properties of thermodynamics
- Lecture 19 - Standard Heat of Formation
- Lecture 20 - The mechanical energy balance
- Lecture 21 - Enthalpy balances without reaction
- Lecture 22 - Energy balance with multiple streams without reaction
- Lecture 23 - Energy balance on heat of solution
- Lecture 24 - Energy balance with heat of reaction
- Lecture 25 - Energy balance with heat of reaction (Continued...)
- Lecture 26 - Energy balance with heat of combustion
- Lecture 27 - Material balance of transient process
- Lecture 28 - Unsteady state energy balance
- Lecture 29 - Least Square Method Linear equation fitting
- Lecture 30 - Non-linear algebraic equation system
- Lecture 31 - Numerical Integration

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[Lecture 33 - Process Flowsheeting and codes](#)

[Lecture 34 - Case Study: Cumene Production](#)

[Lecture 35 - Case Study: Cumene Production \(Continued...\)](#)

Lecture 1 - Solar Energy: An overview of thermal applications

Lecture 2 - Solar radiation

Lecture 3 - Practice problems - Part I

Lecture 4 - Practice problems - Part II

Lecture 5 - Non-concentrating solar collectors - Part I

Lecture 6 - Non-concentrating solar collectors - Part II

Lecture 7 - Non-concentrating solar collectors - Part III

Lecture 8 - Practice problems - Part I

Lecture 9 - Practice problems - Part II

Lecture 10 - Practice problems - Part III

Lecture 11 - Parabolic solar collectors

Lecture 12 - Practice problems

Lecture 13 - Thermal energy storage systems - Part I

Lecture 14 - Thermal energy storage systems - Part II

Lecture 15 - Solar energy utilization methods

Lecture 16 - Classification of energy resources

Lecture 17 - Broad classification and compositional analysis

Lecture 18 - Characteristics and properties of biomass

Lecture 19 - Properties and structural components of biomass

Lecture 20 - Biomass residues and energy conversion routes

Lecture 21 - Utilisation of biomass through bio-chemical and thermo-chemical routes

Lecture 22 - Conversion mechanism of biomass to biogas and its properties

Lecture 23 - Classification of biogas plants

Lecture 24 - Practice problems - I

Lecture 25 - Practice problems - II

Lecture 26 - Practice problems - III

Lecture 27 - Bioconversion of substrates into alcohol

Lecture 28 - Thermo-chemical conversion, torrefaction and combustion processes

Lecture 29 - Thermo-chemical conversion of biomass to solid, liquid and gaseous fuels

Lecture 30 - Gasification process

Lecture 31 - Thermo-chemical conversion processes: pyrolysis, liquefaction and conversion processes

[Lecture 32 - Practice problems - I](#)

[Lecture 33 - Practice problems - II](#)

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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 15 - Hertzian Mechanics
- Lecture 16 - Hertzian Mechanics (Continued...)
- Lecture 17 - Concepts of Surface and interfacial energy
- Lecture 18 - Estimation of Surface and interfacial energy
- Lecture 19 - Estimation of Surface and interfacial energy (Continued...)
- Lecture 20 - Estimation of Surface and interfacial energy (Continued...)
- Lecture 21 - Surface tension of liquid using Young's Equation
- Lecture 22 - Indentation of an elastic half space with interaction
- Lecture 23 - JKR contact mechanics between two spheres with adhesion
- Lecture 24 - JKR contact mechanics between two spheres with adhesion (Continued...)
- Lecture 25 - JKR contact mechanics between two spheres with adhesion (Continued...)
- Lecture 26 - JKR contact mechanics between two cylinders
- Lecture 27 - JKR contact mechanics between two cylinders (Continued...)
- Lecture 28 - Estimation of adhesion hysteresis using rolling contact mechanics
- Lecture 29 - Estimation of adhesion hysteresis using rolling contact mechanics (Continued...)
- Lecture 30 - Adhesion of a rigid punch with convex head on an elastic half-space

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Lecture 31 - Adhesion of a rigid punch with convex head on an elastic half-space (Continued...)

Lecture 32 - Indentation of an elastic half space using a concave indenter

Lecture 33 - Indentation of an elastic half space using a concave indenter: Comparison with a flat plate indenter

Lecture 34 - Numerical Problems on Indentation of an elastic half space using a concave indenter

Lecture 35 - Indentation of an elastic half space using a concave indenter having general ellipsoidal shape: Contact area splitting and multiple indenters

Lecture 36 - Multiplicity of indenters / Contact Area splitting: Adhesion between two rigid spheres and Effect of roughness

Lecture 37 - JKR vs. DMT model

Lecture 38 - Numerical Problems on JKR vs. DMT model

Lecture 39 - Thin, elastic film sandwiched between two rigid parallel plates

Lecture 40 - Thin, elastic film sandwiched between two rigid parallel plates (Continued...)

Lecture 41 - Thin, elastic film sandwiched between two rigid parallel plates (Continued...)

Lecture 42 - Estimation of load required to pull a rigid plate from a thin, elastic adhesive bonded system

Lecture 43 - Estimation of load required to pull a rigid plate from a thin, elastic adhesive bonded system (Continued...)

Lecture 44 - A thin elastic adhesive sandwiched between two parallel plates (perfect slippage at interface between adhesive and top surface)

Lecture 45 - A thin elastic adhesive sandwiched between two parallel disks (perfect slippage at interface between adhesive and top surface)

Lecture 46 - Adhesive layer sandwiched between two parallel disks

Lecture 47 - Peel experiment

Lecture 48 - Peel experiment (Continued...)

Lecture 49 - Bending of thin plate

Lecture 50 - Bending of thin plate (Continued...)

Lecture 51 - Lift-off experiment for measuring adhesion strength

Lecture 52 - Lift-off experiment for measuring adhesion strength (Continued...)

Lecture 53 - Lift-off experiment for measuring adhesion strength (Continued...)

Lecture 54 - Physical Mechanisms of Enhancing Adhesion without using Viscoelastic Effect

Lecture 55 - Physical Mechanisms of Enhancing Adhesion without using Viscoelastic Effect (Continued...)

Lecture 56 - Adhesive Layer with Spatially varying Thickness and Modulus

Lecture 57 - Adhesion of Viscoelastic Spheres

Lecture 58 - Adhesion of Vistoelastic Spheres (Continued...)

Lecture 59 - Adhesion on Rough Surface

Lecture 60 - Adhesion on a Randomly Rough Surface and Summary of the Course content covered

Lecture 1 - Fundamentals of Biology & Biotechnology

Lecture 2 - Glimpses of Microbial World - Bacteria

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

Lecture 14 - Immobilized Enzymes (Continued...)

Lecture 15 - Interphase Mass Transfer and Reaction in Immobilized Enzymes

Lecture 16 - Interphase Mass Transfer and Reaction in Immobilized Enzymes (Continued...)

Lecture 17 - Effectiveness Factor in Immobilized Enzymes

Lecture 18 - Bioenergetics and Glycolysis

Lecture 19 - TCA Cycle

Lecture 20 - Electron Transport Chain & Oxidative Phosphorylation

Lecture 21 - Pentose Phosphate Pathways Glycogenesis & Glycogenolysis

Lecture 22 - Urea Cycle, Gluconeogenesis and Glyoxalate Cycle

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

Lecture 27 - Design of Chemostats

Lecture 28 - Stability of Bioreactors

Lecture 29 - Stability of Bioreactors (Continued...)

Lecture 30 - Introduction to Receptor - Ligand Binding

Lecture 31 - Effects of Ligand Depletion and Multiple Receptors on Binding Kinetics

[Lecture 32 - Effects of Ligand Depletion and Multiple Receptors on Binding Kinetics \(Continued...\)](#)

[Lecture 33 - Receptors-Mediated Endocytosis](#)

[Lecture 34 - Kinetics of Receptor-Mediated Endocytosis](#)

[Lecture 35 - General Model for Receptor-Mediated Endocytosis](#)

[Lecture 36 - Multiple Interacting Microbial Population: Prey-Predator Models](#)

[Lecture 37 - Manufacture of Biochemicals](#)

[Lecture 38 - Manufacture of Biochemicals \(Continued...\) & Strategies for Biomolecules Separation](#)

[Lecture 39 - Strategies for Biomolecules Separation \(Continued...\)](#)

[Lecture 40 - Strategies for Biomolecules Separation \(Continued...\)](#)

Lecture 1 - Introduction

Lecture 2 - Introduction (Continued...)

Lecture 3 - Lab on Chip

Lecture 4 - Lab on Chip (Continued...)

Lecture 5 - Microscale manufacturing practices

Lecture 6 - Photolithography

Lecture 7 - Photolithography (Continued...)

Lecture 8 - Deposition

Lecture 9 - Plastic microfluidic devices

Lecture 10 - Mixing

Lecture 11 - Micro Heat Pipes

Lecture 12 - Mixing (Continued...)

Lecture 13 - Mixing (Continued...)

Lecture 14 - Micro Heat Pipes (Continued...)

Lecture 15 - Mixing (Continued...)

Lecture 16 - Dispersion

Lecture 17 - Dispersion (Continued...)

Lecture 18 - Dispersion (Continued...)

Lecture 19 - Electrowetting

Lecture 20 - Electro osmosis

Lecture 21 - Electrowetting (Continued...)

Lecture 22 - Electro osmosis (Continued...)

Lecture 23 - Dielectrophoresis

Lecture 24 - Dielectrophoresis (Continued...)

Lecture 25 - Dielectrophoresis (Continued...)

Lecture 26 - Scaling dimension and issues

Lecture 27 - Slip flow

Lecture 28 - Microstructured reactor

Lecture 29 - Immiscible flow in microchannel

Lecture 30 - Immiscible flow in microchannel (Continued...)

Lecture 31 - Immiscible flow in microchannel (Continued...)



[Lecture 32 - Scaling dimension and issues \(Continued...\)](#)

[Lecture 33 - Immiscible flow in microchannel \(Continued...\)](#)

[Lecture 34 - Plastic device making](#)

[Lecture 35 - Transport processes and their descriptions](#)

[Lecture 36 - Convective fluid dynamics in microchannels](#)

[Lecture 37 - Microfluidic networks](#)

[Lecture 38 - Electrohydrodynamic atomization](#)

[Lecture 39 - Electrohydrodynamic atomization \(Continued...\)](#)

[Lecture 40 - Interfacial phenomena in thin liquid films](#)

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

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

Lecture 1 - Introduction

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

Lecture 8 - The Homogeneous Flow Theory

Lecture 9 - The Homogeneous Flow Theory (Continued...)

Lecture 10 - Compressible Flow A Recapitulation

Lecture 11 - Compressible Flow A Recapitulation (Continued...)

Lecture 12 - Choked Flow Condition for Homogeneous Flow

Lecture 13 - Drift Flux Model

Lecture 14 - Drift Flux Model (Continued...)

Lecture 15 - Drift Flux Model (Continued...)

Lecture 16 - Drift Flux Model (Continued...)

Lecture 17 - Separated Flow Model

Lecture 18 - Separated Flow Model (Continued...)

Lecture 19 - Separated Flow Model (Continued...)

Lecture 20 - Separated Flow Model - Condition of Choking

Lecture 21 - Separated Flow Model - Condition of Choking (Continued...)

Lecture 22 - Separated Flow Model - Estimation of Frictional Pressure Drop and Void Fraction

Lecture 23 - Separated Flow Model - Estimation of Frictional Pressure Drop and Void Fraction (Continued...)

Lecture 24 - Separated Flow Model - Estimation of Frictional Pressure Drop and Void Fraction (Continued...)

Lecture 25 - Separated Flow Model - Estimation of Frictional Pressure Drop and Void Fraction (Continued...)

Lecture 26 - Analysis of Specific Flow Regimes

Lecture 27 - Analysis of Specific Flow Regimes (Continued...)

Lecture 28 - Analysis of Specific Flow Regimes - Slug Flow (Continued...)

Lecture 29 - Two Phase Flow with Phase Change - An Introduction to Boiling Heat Transfer

Lecture 30 - Bubble Growth

Lecture 31 - Different Types of Nucleation

[Lecture 32 - Ibullition from Hot Surfaces](#)

[Lecture 33 - Cycle of Bubble Growth and Departure](#)

[Lecture 34 - Heat Transfer in Different Regimes of Boiling](#)

[Lecture 35 - Heat Transfer in Different Regimes of Boiling \(Continued...\)](#)

[Lecture 36 - Critical Heat Flux, Film Boiling](#)

[Lecture 37 - Measurement Techniques for Two Phase flow Parameters](#)

[Lecture 38 - Measurement Techniques for Two Phase flow Parameters - Void Fraction Measurement](#)

[Lecture 39 - Measurement Techniques for Two Phase flow Parameters - Void Fraction Measurement \(Continued...\)](#)

[Lecture 40 - Measurement Techniques for Two Phase flow Parameters - Estimation of Flow Patterns](#)

**NPTEL : Novel Separation Processes (Chemical Engineering)**

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

[Lecture 1 - Fundamentals of Separation Processes](#)

[Lecture 2 - Identification of Novel Separation Processes](#)

[Lecture 3 - Membrane Separation Processes](#)

[Lecture 4 - Membrane Separation Processes \(Continued...1\)](#)

[Lecture 5 - Membrane Separation Processes \(Continued...2\)](#)

[Lecture 6 - Membrane Separation Processes \(Continued...3\)](#)

[Lecture 7 - Membrane Separation Processes \(Continued...4\)](#)

[Lecture 8 - Membrane Separation Processes \(Continued...5\)](#)

[Lecture 9 - Membrane Separation Processes \(Continued...6\)](#)

[Lecture 10 - Membrane Separation Processes \(Continued...7\)](#)

[Lecture 11 - Membrane Separation Processes \(Continued...8\)](#)

[Lecture 12 - Membrane Separation Processes \(Continued...9\)](#)

[Lecture 13 - Membrane Separation Processes \(Continued...10\)](#)

[Lecture 14 - Membrane Separation Processes \(Continued...11\)](#)

[Lecture 15 - Membrane Separation Processes \(Continued...12\)](#)

[Lecture 16 - Membrane Separation Processes \(Continued...13\)](#)

[Lecture 17 - Membrane Separation Processes \(Continued...14\)](#)

[Lecture 18 - Membrane Separation Processes \(Continued...15\)](#)

[Lecture 19 - Membrane Separation Processes \(Continued...16\)](#)

[Lecture 20 - Membrane Separation Processes \(Continued...17\)](#)

[Lecture 21 - Membrane Separation Processes \(Continued...18\)](#)

[Lecture 22 - External Field Induced Membrane Separation Processes](#)

[Lecture 23 - External Field Induced Membrane Separation Processes \(Continued...1\)](#)

[Lecture 24 - External Field Induced Membrane Separation Processes \(Continued...2\)](#)

[Lecture 25 - External Field Induced Membrane Separation Processes \(Continued...3\)](#)

[Lecture 26 - External Field Induced Membrane Separation Processes \(Continued...4\)](#)

[Lecture 27 - Gas Separation](#)

[Lecture 28 - Gas Separation \(Continued...\)](#)

[Lecture 29 - Surfactant Based Separation Processes](#)

[Lecture 30 - Surfactant Based Separation Processes \(Continued...\)](#)

[Lecture 31 - Micellar Enhanced Ultrafiltration](#)

[Lecture 32 - Micellar Enhanced Ultrafiltration \(Continued...\)](#)

[Lecture 33 - Liquid Membranes](#)

[Lecture 34 - Liquid Membranes \(Continued...\)](#)

[Lecture 35 - Centrifugal Separation Processes](#)

[Lecture 36 - Chromatographic Separation Processes](#)

[Lecture 37 - Chromatographic Separation Processes \(Continued...\)](#)

[Lecture 38 - Ion Exchange Processes](#)

[Lecture 39 - Electrophoretic Separation Methods](#)

[Lecture 40 - Electrophoretic Separation Methods \(Continued...\)](#)

[Lecture 41 - Supercritical Fluid Extraction](#)

Lecture 1 - Introduction to Process Control

Lecture 2 - Introduction to Process Control (Continued...)

Lecture 3 - Mathematical Modeling (Continued...1)

Lecture 4 - Mathematical Modeling (Continued...2)

Lecture 5 - Mathematical Modeling (Continued...3)

Lecture 6 - Dynamic Behavior of Chemical Processes

Lecture 7 - Dynamic Behavior of Chemical Processes (Continued...1)

Lecture 8 - Dynamic Behavior of Chemical Processes (Continued...2)

Lecture 9 - Dynamic Behavior of Chemical Processes (Continued...3)

Lecture 10 - Dynamic Behavior of Chemical Processes (Continued...4)

Lecture 11 - Dynamic Behavior of Chemical Processes (Continued...5)

Lecture 12 - Dynamic Behavior of Chemical Processes (Continued...6)

Lecture 13 - Dynamic Behavior of Chemical Processes (Continued...7)

Lecture 14 - Dynamic Behavior of Chemical Processes (Continued...8)

Lecture 15 - Feedback Control Schemes

Lecture 16 - Feedback Control Schemes (Continued...1)

Lecture 17 - Feedback Control Schemes (Continued...2)

Lecture 18 - Feedback Control Schemes (Continued...3)

Lecture 19 - Feedback Control Schemes (Continued...4)

Lecture 20 - Feedback Control Schemes (Continued...5)

Lecture 21 - Feedback Control Schemes (Continued...6)

Lecture 22 - Feedback Control Schemes (Continued...7)

Lecture 23 - Feedback Control Schemes (Continued...8)

Lecture 24 - Feedback Control Schemes (Continued...9)

Lecture 25 - Feedback Control Schemes (Continued...10)

Lecture 26 - Feedback Control Schemes (Continued...11)

Lecture 27 - Feedback Control Schemes (Continued...12)

Lecture 28 - Feedback Control Schemes (Continued...13)

Lecture 29 - Feedback Control Schemes (Continued...14)

Lecture 30 - Advanced Control Schemes

Lecture 31 - Advanced Control Schemes (Continued...1)

[Lecture 32 - Advanced Control Schemes \(Continued...2\)](#)

[Lecture 33 - Advanced Control Schemes \(Continued...3\)](#)

[Lecture 34 - Advanced Control Schemes \(Continued...4\)](#)

[Lecture 35 - Instrumentation: General Principles of Measurement Systems](#)

[Lecture 36 - Instrumentation: General Principles of Measurement Systems \(Continued...1\)](#)

[Lecture 37 - Instrumentation: General Principles of Measurement Systems \(Continued...2\)](#)

[Lecture 38 - Instrumentation: General Principles of Measurement Systems \(Continued...3\)](#)

[Lecture 39 - Instrumentation: General Principles of Measurement Systems \(Continued...4\)](#)

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[Lecture 41 - Transducer Elements](#)

[Lecture 42 - Pressure Measurement](#)

[Lecture 43 - Pressure Measurement \(Continued...1\)](#)

[Lecture 44 - Pressure Measurement \(Continued...2\)](#)

Lecture 1 - Introduction

Lecture 2 - Introduction (Continued...)

Lecture 3 - Some Fundamental Surface Related Concepts - I

Lecture 4 - Surface Tension (in terms of molecular interactions)

Lecture 5 - Effect Surface Tension : Laplace Pressure

Lecture 6 - Young Laplace Equation

Lecture 7 - Rayleigh Instability

Lecture 8 - Meso Scale Fabrication Approaches

Lecture 9 - Photo Lithography - I

Lecture 10 - Photo Lithography - II

Lecture 11 - Photo Lithography - III

Lecture 12 - Photo Lithography - IV

Lecture 13 - Photo Lithography - V

Lecture 14 - Nano Imprint Lithography

Lecture 15 - Nano Imprint Lithography (Continued...)

Lecture 16 - Soft Lithography - I

Lecture 17 - Soft Lithography - II

Lecture 18 - Soft Lithography - III

Lecture 19 - Soft Lithography - IV

Lecture 20 - Soft Lithography - V

Lecture 21 - Soft Lithography - VI

Lecture 22 - Atomic Force Microscope - I

Lecture 23 - Atomic Force Microscope - II

Lecture 24 - Atomic Force Microscope - III

Lecture 25 - Atomic Force Microscope - IV

Lecture 26 - Atomic Force Microscope - V

Lecture 27 - Intermolecular Forces between Particles and Surfaces - I

Lecture 28 - Intermolecular Forces between Particles and Surfaces - II

Lecture 29 - Intermolecular Forces between Particles and Surfaces - III

Lecture 30 - Intermolecular Forces between Particles and Surfaces - IV

Lecture 31 - Spontaneous instability and wetting of thin polymer film - I



[Lecture 32 - Spontaneous instability and dewetting of thin polymer film - II](#)

[Lecture 33 - Spontaneous instability and dewetting of thin polymer film - III](#)

[Lecture 34 - Spontaneous instability and dewetting of thin polymer film - IV](#)

[Lecture 35 - Spontaneous instability and dewetting of thin polymer film - V](#)

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[Lecture 37 - Spontaneous instability and dewetting of thin polymer film - VII](#)

[Lecture 38 - Template Guided Dewetting](#)

[Lecture 39 - Elastic Contact Instability and Lithography](#)

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Lecture 1 - Introduction to vector space

Lecture 2 - Introduction to vector space (Continued...)

Lecture 3 - Onto, into, one to one function

Lecture 4 - Vectors

Lecture 5 - Vectors (Continued...)

Lecture 6 - Contraction Mapping

Lecture 7 - Contraction Mapping (Continued...)

Lecture 8 - Matrix, Determinant

Lecture 9 - Eigenvalue Problem in Discrete Domain

Lecture 10 - Eigenvalue Problem in Discrete Domain (Continued...)

Lecture 11 - Eigenvalue Problem in Discrete Domain (Continued...)

Lecture 12 - Eigenvalue Problem in Discrete Domain (Continued...)

Lecture 13 - Stability Analysis

Lecture 14 - Stability Analysis (Continued...)

Lecture 15 - Stability Analysis (Continued...)

Lecture 16 - More Examples

Lecture 17 - Partial Differential Equations

Lecture 18 - Partial Differential Equations (Continued...)

Lecture 19 - Eigenvalue Problem in Continuous Domain

Lecture 20 - Special ODEs

Lecture 21 - Adjoint Operator

Lecture 22 - Theorems of Eigenvalues and Eigenfunction

Lecture 23 - Solution PDE : Separation of Variables Method

Lecture 24 - Solution of Parabolic PDE : Separation of variables method

Lecture 25 - Solution of Parabolic PDE : Separation of Variables Method (Continued...)

Lecture 26 - Solution of Higher Dimensional PDEs

Lecture 27 - Solution of Higher Dimensional PDEs (Continued...)

Lecture 28 - Four Dimensional Parabolic PDE

Lecture 29 - Solution of Elliptic and Hyperbolic PDE

Lecture 30 - Solution of Elliptic and Hyperbolic PDE (Continued...)

Lecture 31 - PDE in Cylindrical and Spherical Coordinate

[Lecture 32 - Solution of non-homogeneous PDE](#)

[Lecture 33 - Solution of non-homogeneous PDE \(Continued...\)](#)

[Lecture 34 - Solution of non-homogeneous Parabolic PDE](#)

[Lecture 35 - Solution of non-homogeneous Elliptic PDE](#)

[Lecture 36 - Solution of non-homogeneous Elliptic PDE \(Continued...\)](#)

[Lecture 37 - Similarity Solution](#)

[Lecture 38 - Similarity Solution \(Continued...\)](#)

[Lecture 39 - Integral Method](#)

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[Lecture 1 - Fundamentals of Separation Processes and Introduction of Membrane System](#)

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[Lecture 5 - Modeling of Reverse Osmosis](#)

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[Lecture 8 - Osmotic Pressure Controlling Filtration \(Continued...\)](#)

[Lecture 9 - Osmotic Pressure Controlling Filtration \(Continued...\)](#)

[Lecture 10 - Osmotic Pressure Controlling Filtration \(Continued...\)](#)

[Lecture 11 - Osmotic Pressure Controlling Filtration \(Continued...\)](#)

[Lecture 12 - Osmotic Pressure Controlling Filtration \(Continued...\)](#)

[Lecture 13 - Modeling of Gel Layer Controlling Filtration](#)

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[Lecture 15 - Modeling of Gel Layer Controlling Filtration \(Continued...\) and Resistance in Series Models](#)

[Lecture 16 - Design of Membrane Module](#)

[Lecture 17 - Design of Membrane Module \(Continued...\)](#)

[Lecture 18 - Design of Membrane Module \(Continued...\)](#)

[Lecture 19 - Modeling of Dialysis](#)

[Lecture 20 - Modeling of Dialysis \(Continued...\)](#)

Lecture 1 - Introduction - 1

Lecture 2 - Introduction - 2

Lecture 3 - Introduction - 3

Lecture 4 - Fundamental Concepts Related to Surface Tension - 1

Lecture 5 - Fundamental Concepts Related to Surface Tension - 2

Lecture 6 - Fundamental Concepts Related to Surface Tension - 3

Lecture 7 - Fundamental Concepts Related to Surface Tension - 4

Lecture 8 - Components of Surface Tension - 1

Lecture 9 - Components of Surface Tension - 2

Lecture 10 - Self Assembly of Surfactant Molecules

Lecture 11 - Laplace Pressure

Lecture 12 - Photo Lithography - 1

Lecture 13 - Photo Lithography - 2

Lecture 14 - Photo Lithography - 3

Lecture 15 - Photo Lithography - 4

Lecture 16 - Photo Lithography - 5

Lecture 17 - Photo Lithography - 6

Lecture 18 - Soft Lithography - I

Lecture 19 - Soft Lithography - 2

Lecture 20 - Soft Lithography - 3

Lecture 21 - Soft Lithography - 4

Lecture 22 - Soft Lithography - 5

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Lecture 24 - Atomic Force Microscope - 1

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Lecture 28 - Atomic Force Microscope - 5

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Lecture 30 - Dewetting - 1

Lecture 31 - Dewetting - 2

[Lecture 32 - VdW Interaction Between Two Surfaces](#)

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[Lecture 39 - Elastic Contact Instability - I](#)

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Lecture 1 - Brief Introduction to Multiphase Flow

Lecture 2 - Brief Introduction to Multiphase Flow (Continued...)

Lecture 3 - Two Phase Flow through Micro Channels

Lecture 4 - Two Phase Flow through Micro Channels (Continued...)

Lecture 5 - Criteria for Confinement for in Case of Two Phase Flow

Lecture 6 - Pertinent Dimensionless Numbers in Two Phase

Lecture 7 - Flow Pattern Maps for Milli and Micro Systems

Lecture 8 - Pattern Transition from Energy Minimisation Principle

Lecture 9 - Experimental Identification of Flow Regimes

Lecture 10 - Experimental Identification of Flow Regimes (Continued...)

Lecture 11 - Flow Regimes and Void Fraction Estimation

Lecture 12 - Influence of Operating Parameter on Flow Patterns

Lecture 13 - Influence of Operating Parameter on Flow Patterns (Continued...)

Lecture 14 - Influence of Operating Parameter on Flow Patterns (Continued...)

Lecture 15 - Influence of Operating Parameter on Flow Patterns (Continued...)

Lecture 16 - Void Fraction Characteristic Mini and Micro Channel

Lecture 17 - Void Fraction and Pressure Drop in Reduced Dimensions - Experimental results

Lecture 18 - Void Fraction and Pressure Drop in Reduced Dimensions - Experimental results (Continued...)

Lecture 19 - Theoretical Analysis of Two Phase Flow in Reduced Dimensions

Lecture 20 - Theoretical Analysis of Two Phase Flow in Reduced Dimensions (Continued...)

Lecture 21 - Flow Pattern based Analysis in Micro Systems - Drift Flux Model

Lecture 22 - Flow Pattern based Modelling - Slug Flow Model

Lecture 23 - Flow Boiling in Microchannels

Lecture 24 - Tutorial - I

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Lecture 1 - Introduction

Lecture 2 - Introduction (Continued...)

Lecture 3 - First Law of Thermodynamics

Lecture 4 - Second Law of Thermodynamics

Lecture 5 - Second Law of Thermodynamics (Continued...)

Lecture 6 - Entropy Change during Spontaneous Processes

Lecture 7 - Criteria of Spontaneity

Lecture 8 - Criteria of Spontaneity (Continued...)

Lecture 9 - Thermodynamic Network

Lecture 10 - Thermodynamic Network (Continued...)

Lecture 11 - Tutorial 1

Lecture 12 - Gibbs free energy as a function of temperature and pressure

Lecture 13 - P-v-T behaviour of gases

Lecture 14 - P-v-T behaviour (Continued...)

Lecture 15 - P-v-T behaviour (Continued...)

Lecture 16 - P-v-T behaviour (Continued...)

Lecture 17 - Tutorial 2

Lecture 18 - Property estimation from P-v-T behaviour

Lecture 19 - Property estimation (Continued...)

Lecture 20 - Concept of chemical potential

Lecture 21 - Chemical potential (Continued...)

Lecture 22 - Homogeneous open systems

Lecture 23 - Homogeneous open systems (Continued...)

Lecture 24 - Heterogeneous Closed Systems

Lecture 25 - Tutorial 3

Lecture 26 - Concept of fugacity

Lecture 27 - Fugacity (Continued...)

Lecture 28 - Estimation of fugacity coefficients

Lecture 29 - Fugacity of condensed phase

Lecture 30 - Mixtures

Lecture 31 - Mixtures (Continued...)



[Lecture 32 - Tutorial 4](#)

[Lecture 33 - Partial molar properties](#)

[Lecture 34 - Partial molar properties \(Continued...\)](#)

[Lecture 35 - Partial molar fugacity](#)

[Lecture 36 - Ideal solutions](#)

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[Lecture 38 - Ideal solutions \(Continued...\)](#)

[Lecture 39 - Ideal solutions \(Continued...\)](#)

[Lecture 40 - Non-ideal solutions](#)

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[Lecture 51 - Partial and Complete Immiscibility of Liquid Mixtures \(Continued...\)](#)

[Lecture 52 - Phase Equilibrium for Mass Transfer Processes](#)

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[Lecture 61 - Equilibrium constant and its estimation](#)

[Lecture 62 - Relation of Equilibrium constant to composition](#)

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Lecture 9 - Flash Distillation and Design problem

Lecture 10 - Fractionation

Lecture 11 - Fractionation (Continued...)

Lecture 12 - McCabe-Thiele construction for number of ideal stages

Lecture 13 - Optimum Design

Lecture 14 - Multi-component fractionation design

Lecture 15 - Batch Distillation

Lecture 16 - Practical issues in designing distillation processes

Lecture 17 - Design of absorbers

Lecture 18 - Design of absorbers (Continued...)

Lecture 19 - Design of absorbers (Continued...)

Lecture 20 - Tower and Tower internals

Lecture 21 - Tower and Tower internals (Continued...)

Lecture 22 - Tower and Tower internals (Continued...)

Lecture 23 - Sieve Tray Design

Lecture 24 - Sieve Tray Design (Continued...)

Lecture 25 - Sieve Tray Design (Continued...)

Lecture 26 - Bubble Cap Tray Design

Lecture 27 - Bubble Cap Tray Design (Continued...)

Lecture 28 - Bubble Cap Tray Design (Continued...)

Lecture 29 - Tower and Tower internals (Packed Tower Design)

Lecture 30 - Tower and Tower internals (Packed Tower Design) (Continued...)

Lecture 31 - Adsorption

- Lecture 32 - Packed bed adsorption
- Lecture 33 - Packed bed adsorber design
- Lecture 34 - Packed bed adsorber design (Continued...)
- Lecture 35 - Liquid-liquid extraction (LLE)
- Lecture 36 - Liquid-liquid extraction (L2)
- Lecture 37 - Liquid-liquid extraction (L3)
- Lecture 38 - Liquid-liquid extraction (L4)
- Lecture 39 - Liquid-liquid extraction (L5)
- Lecture 40 - Design of Mass Transfer Processes (Review)
- Lecture 41 - Design of Heat Transfer Processes - Introduction
- Lecture 42 - Double Pipe Heat exchanger
- Lecture 43 - Double Pipe Heat exchanger (Continued...)
- Lecture 44 - Double Pipe Heat exchanger (Continued...)
- Lecture 45 - Design of Shell and Tube Heat Exchangers - a general overview
- Lecture 46 - Design of Shell and Tube Heat Exchangers - a general overview (Continued...)
- Lecture 47 - Shell and Tube Heat Exchanger - Design
- Lecture 48 - Shell and Tube Heat Exchanger - Design
- Lecture 49 - Heat exchanger Network Analysis
- Lecture 50 - Heat exchanger Network Analysis (Continued...)
- Lecture 51 - Heat exchanger Network Analysis (Continued...)
- Lecture 52 - Heat exchanger Network Analysis (Continued...)
- Lecture 53 - Heat exchanger Network Analysis (Continued...)
- Lecture 54 - Plant Hydraulics
- Lecture 55 - Plant Hydraulics (Continued...)
- Lecture 56 - Plant Hydraulics (Continued...)
- Lecture 57 - Plant Hydraulics (End)
- Lecture 58 - Process Vessels
- Lecture 59 - Process Instrumentation and Control
- Lecture 60 - Engineered Safety
- Lecture 61 - Process Utilities
- Lecture 62 - Process Design using Simulators
- Lecture 63 - Process Packages
- Lecture 64 - Design of a 10 TPD Mono-nitrotoluene plant



Lecture 1 - Introduction

Lecture 2 - Introduction (Continued...)

Lecture 3 - Constitutive relations

Lecture 4 - Constitutive relations - Mass transfer and thermodynamics

Lecture 5 - Process diagrams

Lecture 6 - Special functions

Lecture 7 - Partial differential equations

Lecture 8 - Partial differential equations - Separation of variables

Lecture 9 - PDE - Separation of variables (Continued...)

Lecture 10 - PDE - Integral transforms

Lecture 11 - Numerical techniques of solving PDE - Discretization

Lecture 12 - Stability of finite difference schemes

Lecture 13 - Numerical solution of PDE - Method of lines

Lecture 14 - Numerical solution of implicit formulation - Tridiagonal matrix

Lecture 15 - Numerical solution of PDE - Finite volume method

Lecture 16 - Perturbation methods

Lecture 17 - Asymptotics

Lecture 18 - Matched Asymptotics

Lecture 19 - Stability of dynamical systems

Lecture 20 - Stability of dynamical systems (Continued...)

Lecture 21 - Modelling transport phenomena problems - Part 1

Lecture 22 - Modelling transport phenomena problems - Part 2

Lecture 23 - Modelling transport phenomena problems - Part 3

Lecture 24 - Modelling transport phenomena problems - Part 4

Lecture 25 - Modelling transport phenomena problems - Part 5

Lecture 26 - Modelling reaction systems - Packed bed catalytic reactor

Lecture 27 - Modelling intraparticle transport and catalysis

Lecture 28 - Modelling pore diffusion and reaction

Lecture 29 - Modelling enzymatic reactions

Lecture 30 - Demonstration of COMSOL Multiphysics

Lecture 31 - Modelling of multistage distillation process

- Lecture 32 - FUG method of stage calculations
- Lecture 33 - MESH equations and DOF analysis
- Lecture 34 - Tearing method
- Lecture 35 - Bubble point method stage calculations
- Lecture 36 - Simultaneous correction method
- Lecture 37 - Block tridiagonal matrix
- Lecture 38 - Simple binary batch distillation
- Lecture 39 - Multistage batch distillation
- Lecture 40 - Heat exchanger network design pinch analysis
- Lecture 41 - Pinch point temperature
- Lecture 42 - Heat exchanger network synthesis
- Lecture 43 - Solving a distillation column using Aspen plus
- Lecture 44 - Solving two unit operations using Aspen Plus
- Lecture 45 - Solving multiple units using Aspen Plus
- Lecture 46 - Dispersed phase modelling - Introduction
- Lecture 47 - Population balance equation
- Lecture 48 - Dispersed phase modelling - Breakage process
- Lecture 49 - Drop size distribution in lean mixtures
- Lecture 50 - Mass transfer in lean liquid-liquid dispersion
- Lecture 51 - Dispersed phase modelling - Aggregation
- Lecture 52 - Dispersed phase modelling - Aerosol dynamics
- Lecture 53 - Dispersed phase modelling - Aerosol dynamics (Continued...)
- Lecture 54 - Solution of the population balance equation
- Lecture 55 - Numerical solution of the population balance equation
- Lecture 56 - Kinetic monte carlo simulation
- Lecture 57 - Response surface methodology
- Lecture 58 - Design of experiments
- Lecture 59 - Artificial neural network
- Lecture 60 - Supervised training

Lecture 1 - Introduction and motivation

Lecture 2 - Dynamics of linear first order autonomous systems

Lecture 3 - Dynamics of linear first order autonomous systems (Continued...)

Lecture 4 - Lumped parameter analysis of cooling of a body

Lecture 5 - Lumped parameter analysis of cooling of a body (Continued...)

Lecture 6 - Introduction to higher order systems

Lecture 7 - Phase plane analysis of linear autonomous second order systems

Lecture 8 - Phase plane analysis of linear autonomous second order systems (Continued...)

Lecture 9 - Analysis of a free spring-mass system

Lecture 10 - Analysis of a free spring-mass system (Continued...)

Lecture 11 - Dynamics of non-autonomous systems

Lecture 12 - Similarity solution for non-autonomous higher order dynamics

Lecture 13 - Similarity solution for non-autonomous higher order dynamics (Continued...)

Lecture 14 - Analysis of a forced spring-mass system

Lecture 15 - Analysis of a forced spring-mass system (Continued...)

Lecture 16 - Phase portraits of linear autonomous systems of order three and higher

Lecture 17 - Phase portraits of linear autonomous systems of order three and higher (Continued...)

Lecture 18 - Analysis of complex reaction systems

Lecture 19 - Analysis of complex reaction systems (Continued...)

Lecture 20 - Analysis of complex reaction systems (Continued...)

Lecture 21 - Introduction to non-linear systems

Lecture 22 - Logistic population growth model

Lecture 23 - Logistic population growth model (Continued...)

Lecture 24 - Logistic population growth with harvesting

Lecture 25 - Logistic population growth with harvesting (Continued...)

Lecture 26 - Logistic population growth with threshold population

Lecture 27 - Logistic population growth with threshold population (Continued...)

Lecture 28 - Analysis of population dynamics in discrete domain

Lecture 29 - Analysis of fixed points and bifurcation in discrete domain

Lecture 30 - Analysis of fixed points and bifurcation in discrete domain (Continued...)

Lecture 31 - More on bifurcations in non-linear systems



- Lecture 32 - Non-linear systems in higher dimensions
- Lecture 33 - Reactor stability analysis
- Lecture 34 - Reactor stability analysis (Continued...)
- Lecture 35 - Reactor stability analysis (Continued...)
- Lecture 36 - Analysis of infectious disease dynamics
- Lecture 37 - Analysis of infectious disease dynamics (Continued...)
- Lecture 38 - Analysis of infectious disease dynamics (Continued...)
- Lecture 39 - Analysis of atmosphere dynamics using Lorenz equations
- Lecture 40 - Analysis of atmosphere dynamics using Lorenz equations (Continued...)
- Lecture 41 - Analysis of system dynamics in transform domain
- Lecture 42 - Analysis of first order system subjected to ideal forcing functions
- Lecture 43 - Analysis of first order system subjected to ideal forcing functions (Continued...)
- Lecture 44 - Analysis of response of second order systems
- Lecture 45 - Analysis of response of second order systems (Continued...)
- Lecture 46 - Analysis of (p,q) order systems
- Lecture 47 - Analysis of (p,q) order systems (Continued...)
- Lecture 48 - Analysis of multiple input - multiple output systems
- Lecture 49 - Block diagrams and inter-conversion of state-space and transform domain models
- Lecture 50 - Analysis of inverse response systems
- Lecture 51 - Analysis of dynamics of discrete-time systems
- Lecture 52 - Sampling and reconstruction of continuous signals
- Lecture 53 - Conversion of continuous models to discrete-time models
- 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

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

[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](#)

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- 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
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- Lecture 36 - Practical demonstration of Rubber mixing on a two roll and using an internal mixer
- Lecture 37 - Molding Techniques
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- Lecture 40 - Rheology of Injection moulding process
- Lecture 41 - Plastic and fiber-related processing
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- Lecture 43 - Wire coating, Garvey die, Profile Extrusion
- Lecture 44 - Introduction to FEA based computationalfluid mechanics on extrusion - 1
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- Lecture 52 - Flow meters
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- Lecture 54 - Recap of Fluid Dynamics
- Lecture 55 - Cavitation and Net Positive Suction Head
- Lecture 56 - Flow Metering and Associated Problems
- Lecture 57 - Flow Metering and Associated Problems (Continued... )
- Lecture 58 - Flow Metering and Associated Problems (Continued... )
- Lecture 59 - Turbulence
- Lecture 60 - Flow Through Porous Media

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Lecture 2 - Pressure maintenance and Well Patterns

Lecture 3 - Need for EOR and Screening Methods

Lecture 4 - Sweep and Displacement Efficiencies

Lecture 5 - Fundamental of immiscible fluid displacement processes

Lecture 6 - Buckley Leverette Theorem for one dimensional immiscible displacement

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Lecture 8 - Effects of various parameters on recovery by water flood

Lecture 9 - Chemical Enhanced Oil Recovery Methods

Lecture 10 - Enhanced Oil Recovery by Polymer Flooding - I

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Lecture 12 - Enhanced Oil Recovery by Polymer Flooding - III

Lecture 13 - Oil Recovery by Polymer Flooding: Lab Study and Recovery Calculations

Lecture 14 - Surfactant Flooding: Properties of Surfactants

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Lecture 17 - Phase Behaviour of Surfactant Stabilized Microemulsions

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Lecture 19 - Micellar - Polymer Flooding

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Lecture 24 - Introduction to Miscible Flooding, Thermodynamics of miscibility

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Lecture 26 - Minimum Miscibility Pressure (MMP)

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- Lecture 34 - Thermal Oil Recovery: Hot Water and Steam flooding
- Lecture 35 - Steam Flooding for EOR
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- Lecture 37 - Thermal Oil Recovery-In-Situ Combustion
- Lecture 38 - Air Requirement in In-situ Combustion
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- Lecture 40 - Low salinity water flooding
- Lecture 41 - Low salinity water flooding (Continued...)
- Lecture 42 - Low salinity water flooding (Continued...)
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- Lecture 44 - Low salinity water flooding in Carbonate Reservoir - Smart Water Flooding
- Lecture 45 - Nanotechnology based EOR
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- Lecture 47 - Microbial Enhanced Oil Recovery
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- Lecture 49 - Plasma pulse technology and Exothermic Chemical Treatment (ECT) in EOR
- Lecture 50 - Enhanced Gas Recoveries
- Lecture 51 - Water Shutoff and Profile Modification
- Lecture 52 - Reservoir Simulation Studies for Enhanced Oil Recovery
- Lecture 53 - Introduction to Artificial Intelligence and Machine Learning in EOR
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- Lecture 55 - Review of Classes
- Lecture 56 - Review of Classes (Continued...)
- Lecture 57 - Review of Classes (Continued...)
- Lecture 58 - Case Studies of EOR Methods
- Lecture 59 - Case Studies of EOR Methods (Continued...)
- Lecture 60 - Role of Petroleum Engineering for design and operation of EOR Methods

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Lecture 2 - Adsorbents

Lecture 3 - Key Features of Adsorption, Thermodynamic Background

Lecture 4 - Adsorption Isotherm

Lecture 5 - Langmuir Isotherm

Lecture 6 - Multicomponent Langmuir and Other Isotherms

Lecture 7 - Other Important Isotherms (Continued...)

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Lecture 12 - Gas Sorption

Lecture 13 - Surface Area Calculations

Lecture 14 - Pore Size Analysis

Lecture 15 - Limitations of BET Analysis

Lecture 16 - Adsorption and Diffusion Models

Lecture 17 - Film Diffusion

Lecture 18 - Linear Driving Force Model

Lecture 19 - Intraparticle Adsorption Diffusion Model

Lecture 20 - Slurry Adsorption

Lecture 21 - Fixed Bed Adsorption

Lecture 22 - Mass Transfer Zone Modelling

Lecture 23 - Fixed Bed Design: Thomas Model

Lecture 24 - Fixed Bed Design: Adams-Bohart and Other Models

Lecture 25 - Fixed Bed Design: Constant Pattern Behaviour

Lecture 26 - Fixed Bed Design: Multi-Scale Model

Lecture 27 - Fixed Bed Adsorption: Illustrative Problems

Lecture 28 - Introduction to Pressure Swing Adsorption (PSA)

Lecture 29 - Modelling PSA Systems

Lecture 30 - Design of Medical Grade Oxygen Concentrator

Lecture 31 - Introduction to Chromatography

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- Lecture 1 - Thermodynamics and the Chemical Industry
- Lecture 2 - James Prescott Joule and the first law
- Lecture 3 - Sadi Carnot and the second law
- Lecture 4 - Equilibrium and Extrema in work
- Lecture 5 - Illustrative Calculations - I
- Lecture 6 - Properties of pure substances
- Lecture 7 - The p-h chart
- Lecture 8 - Work calculation
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- Lecture 10 - Heat-Work Interconversion Devices
- Lecture 11 - Refrigeration / Thermodynamics of mixtures
- Lecture 12 - The Gibbs Duhem equation
- Lecture 13 - Models for Excess Gibbs Free Energy
- Lecture 14 - Van Laar model
- Lecture 15 - Gaseous and liquid mixtures
- Lecture 16 - Separation Work / Equations of state
- Lecture 17 - Chemical potentials in gas and condensed phases
- Lecture 18 - Vapour Liquid Equilibria - I
- Lecture 19 - Vapour Liquid Equilibria - II
- Lecture 20 - Solvent-Solvent mixtures
- Lecture 21 - Solvent-Solute mixtures
- Lecture 22 - Liquid-liquid equilibria
- Lecture 23 - An industrial example
- Lecture 24 - Liquid-liquid equilibria / Reaction Equilibria
- Lecture 25 - Reaction Equilibria
- Lecture 26 - Illustrative Examples - I
- Lecture 27 - Illustrative Examples - II
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- Lecture 29 - Simultaneous Relations
- Lecture 30 - Thermodynamic Consistency / Reverse Osmosis
- Lecture 31 - Miscellaneous topics in phase equilibria

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Lecture 1 - Motivation for CFD and Introduction to the CFD approach

Lecture 2 - Illustration of the CFD approach through a worked out example

Lecture 3 - Eulerian approach, Conservation Equation, Derivation of Mass Conservation Equation and Statement of the momentum conservation equation

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

Lecture 24 - Gauss-Jordan method; LU decomposition method; TDMA and Thomas algorithm

Lecture 25 - Basic iterative methods for linear algebraic equations: Description of point -Jacobi, Gauss-Seidel and SOR methods

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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

Lecture 45 - Unstructured grid generation; Domain nodalization; Advancing front method for triangulation

Lecture 46 - Delaunay triangulation method for unstructured grid generation

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 2 - Computational and Error Analysis

Lecture 3 - Linear Equations - Part 1

Lecture 4 - Linear Equations - Part 2

Lecture 5 - Linear Equations - Part 3

Lecture 6 - Linear Equations - Part 4

Lecture 7 - Linear Equations - Part 5

Lecture 8 - Linear Equations - Part 6

Lecture 9 - Non Linear Algebraic Equations - Part 1

Lecture 10 - Non Linear Algebraic Equations - Part 2

Lecture 11 - Non Linear Algebraic Equations - Part 3

Lecture 12 - Non Linear Algebraic Equations - Part 4

Lecture 13 - Non Linear Algebraic Equations - Part 5

Lecture 14 - Non Linear Algebraic Equations - Part 6

Lecture 15 - Regression and Interpolation - Part 1

Lecture 16 - Regression and Interpolation - Part 2

Lecture 17 - Regression and Interpolation - Part 3

Lecture 18 - Regression and Interpolation - Part 4

Lecture 19 - Regression and Interpolation - Part 5

Lecture 20 - Differentiation and Integration - Part 1

Lecture 21 - Differentiation and Integration - Part 2

Lecture 22 - Differentiation and Integration - Part 3

Lecture 23 - Differentiation and Integration - Part 4

Lecture 24 - Differentiation and Integration - Part 5

Lecture 25 - Ordinary Differential Equations (initial value problems) - Part 1

Lecture 26 - Ordinary Differential Equations (initial value problems) - Part 2

Lecture 27 - Ordinary Differential Equations (initial value problems) - Part 3

Lecture 28 - Ordinary Differential Equations (initial value problems) - Part 4

Lecture 29 - Ordinary Differential Equations (initial value problems) - Part 5

Lecture 30 - Ordinary Differential Equations (initial value problems) - Part 6

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**NPTEL : Particle Characterization (PG) (Chemical Engineering)**

**Co-ordinators : Dr. R. Nagarajan**

Lecture 1 - Introduction: Why study particle characterization?

Lecture 2 - Introduction: Classification of particle characteristics

Lecture 3 - Morphological Characterization: Shape analysis methods

Lecture 4 - Morphological Characterization: Techniques of shape assessment

Lecture 5 - Morphological Characterization: Decision rules

Lecture 6 - Morphological Characterization: Static vs dynamic methods of size analysis

Lecture 7 - Morphological Characterization: Static methods of size analysis

Lecture 8 - Morphological Characterization: Light scattering from spherical particles

Lecture 9 - Morphological Characterization: Particle counters

Lecture 10 - Morphological Characterization: Particle size distributions

Lecture 11 - Morphological Characterization: Acoustic Attenuation Spectroscopy

Lecture 12 - Morphological Characterization: Nano-particle size analysis

Lecture 13 - Structural Characterization

Lecture 14 - Interfacial Characterization

Lecture 15 - Surface Adhesion: Forces

Lecture 16 - Surface Adhesion: Electrostatic & Surface-Tension Forces

Lecture 17 - Surface Adhesion: Adhesion Force Measurement

Lecture 18 - Particle Removal: Methods

Lecture 19 - Particle Removal: Wet Cleaning

Lecture 20 - Particle Cohesion: Forces

Lecture 21 - Particle Cohesion: Flowability Implications

Lecture 22 - Transport Properties: Diffusion & Electrostatic Field Effects

Lecture 23 - Transport Properties: Drag & Inertia

Lecture 24 - Transport Properties: Deposition Fluxes & Rates

Lecture 25 - Transport Properties: Illustrative Application

Lecture 26 - Chemical & Compositional Characterization: Reactivity

Lecture 27 - Chemical & Compositional Characterization: Analytical Methods

Lecture 28 - Chemical & Compositional Characterization: XRD & AFM

Lecture 29 - Nano-particle Characterization: Bottom-Up Synthesis Methods

Lecture 30 - Nano-particle Characterization: Top-Down Synthesis Methods

Lecture 31 - Nano-particle Characterization: Dispersion

[Lecture 32 - Nano-particle Characterization: Properties & Techniques](#)

[Lecture 33 - Practical Relevance of Particle Characterization: Nano-Fluids](#)

[Lecture 34 - Practical Relevance of Particle Characterization: Filtration](#)

[Lecture 35 - Practical Relevance of Particle Characterization: Cleanrooms](#)

[Lecture 36 - Practical Relevance of Particle Characterization: High-Technology Manufacturing](#)

[Lecture 37 - Practical Relevance of Particle Characterization: Explosivity](#)

[Lecture 38 - Practical Relevance of Particle Characterization: Environment & Human Health](#)

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Lecture 2 - Random Variables

Lecture 3 - Discrete Probability Distributions

Lecture 4 - Example Set - I

Lecture 5 - Continuous probability distributions

Lecture 6 - Normal probability distribution

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Lecture 8 - Exploratory Data Analysis - Part B

Lecture 9 - Example Set - II

Lecture 10 - Example Set - III

Lecture 11 - Random samples: Sampling distribution of the mean (Part A)

Lecture 12 - Random samples: Sampling distribution of the mean (Part B)

Lecture 13 - Point Estimation

Lecture 14 - Sampling distributions and the Central Limit Theorem

Lecture 15 - Example Set - IV Part A

Lecture 16 - Estimation of Population Parameters Using Moments

Lecture 17 - Confidence Intervals (Part A)

Lecture 18 - Confidence Intervals (Part B)

Lecture 19 - The T-distribution

Lecture 20 - Chi-square distribution

Lecture 21 - F-Distribution

Lecture 22 - Example Set - V

Lecture 23 - Hypothesis Testing - Part A

Lecture 24 - Hypothesis Testing - Part B

Lecture 25 - Hypothesis Testing - Part C

Lecture 26 - Analysis of Experiments involving Single Factor - Part A

Lecture 27 - Analysis of Experiments involving Single Factor - Part B

Lecture 28 - Blocking and Randomization

Lecture 29 - Example Set - VI - Part A

Lecture 30 - Example Set - VI - Part B

Lecture 31 - Factorial Design of Experiments - Part A

[Lecture 32 - Factorial Design of Experiments - Part B: 22 Factorial Design](#)

[Lecture 33 - Fractional Factorial Design - Part A](#)

[Lecture 34 - Fractional Factorial Design - Part B](#)

[Lecture 35 - Factorial Design of Experiments: Example Set \(Part A\)](#)

[Lecture 36 - Factorial Design of Experiments: Example Set \(Part B\)](#)

[Lecture 37 - Factorial Design of Experiments: Example Set \(Part C\)](#)

[Lecture 38 - Regression Analysis: Part A](#)

[Lecture 39 - Regression Analysis: Part B](#)

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[Lecture 42 - Regression Analysis: Example Set 8](#)

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[Lecture 44 - Regression Analysis: Example Set 8 \(Continued...\)](#)

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[Lecture 46 - Orthogonal Model Fitting Concepts - Part B](#)

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- Lecture 2 - Stratified flow in a micro channel: Velocity profiles
- Lecture 3 - Stratified flow in a micro channel: Effects of physical parameters
- Lecture 4 - Flow regimes in microchannels: Modeling and Experiments
- Lecture 5 - Scaling Analysis: Introduction
- Lecture 6 - Scaling Analysis: Worked Examples
- Lecture 7 - Interfacial tension and its role in Multiphase flows
- Lecture 8 - Eulerian and Lagrangian approaches
- Lecture 9 - Reynolds Transport Theorem and the Equation of Continuity
- Lecture 10 - Derivation of Navier-Stokes equation
- Lecture 11 - Vector operations in general orthogonal coordinates: Grad., Div., Lapacian
- Lecture 12 - Normal and shear stresses on arbitrary surfaces: Force balance
- Lecture 13 - Normal and shear stresses on arbitrary surfaces: Stress Tensor formulation
- Lecture 14 - Stresses on deforming surfaces: Introduction to Perturbation Theory
- Lecture 15 - Pulsatile flow: Analytical solution
- Lecture 16 - Pulsatile flow: Analytical solution and perturbation solution for  $R_w = 1$
- Lecture 17 - Pulsatile flow: Perturbation solution for  $R_w = 1$
- Lecture 18 - Viscous heating: Apparent viscosity in a viscometer
- Lecture 19 - Domain perturbation methods: Flow between wavy walls
- Lecture 20 - Flow between wavy walls: Velocity profile
- Lecture 21 - Introduction to stability of dynamical systems: ODEs
- Lecture 22 - Stability of distributed systems (PDEs): reaction diffusion example
- Lecture 23 - Stability of a reaction-diffusion system (Continued...)
- Lecture 24 - Rayleigh-Benard convection: Physics and governing equations
- Lecture 25 - Rayleigh-Benard convection: Linear stability analysis - Part 1
- Lecture 26 - Rayleigh-Benard convection: Linear stability analysis - Part 2
- Lecture 27 - Rayleigh-Benard convection: Linear stability analysis - Part 3
- Lecture 28 - Rayleigh Benard convection: Discussion of results
- Lecture 29 - Rayleigh-Taylor heavy over light instability
- Lecture 30 - Rayleigh-Taylor instability (Continued...)
- Lecture 31 - Capillary jet instability: Problem formulation

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[Lecture 39 - Flow in a circular curved channel: Governing equations and scaling](#)

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Lecture 11 - A review of Fourier transforms - Lecture 3.4 (Discrete time Fourier transform)

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Lecture 13 - A review of Fourier transforms - Lecture 3.6 (Discrete Fourier transform)

Lecture 14 - A review of Fourier transforms - MATLAB demo of Fourier transform and periodogram

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Lecture 16 - Duration and Bandwidth - Bandwidth equation and Instantaneous frequency

Lecture 17 - Duration and Bandwidth - Instantaneous frequency and analytic signals

Lecture 18 - Duration and Bandwidth - Duration-Bandwidth principle

Lecture 19 - Duration and Bandwidth - Requirements of time-frequency analysis techniques

Lecture 20 - Duration and Bandwidth - Requirements of time-frequency analysis and techniques

Lecture 21 - Short-time Fourier transform - Short-time Fourier transform

Lecture 22 - Short-time Fourier transform - Auxillary (MATLAB demonstration)

Lecture 23 - Short-time Fourier transform - Properties of STFT

Lecture 24 - Practical aspects of STFT

Lecture 25 - Closing Remarks

Lecture 26 - Wigner-Ville Distributions

Lecture 27 - Properties of WVD

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Lecture 29 - Discrete WVD

Lecture 30 - Pseudo and Smoothed WVD

Lecture 31 - Cohens class and smoothed WVD

- Lecture 32 - Cohens class and smoothed WVD
- Lecture 33 - Cohens class and Ambiguity functions
- Lecture 34 - Affine class and closing remarks
- Lecture 35 - Continuous Wavelet Transform
- Lecture 36 - Continuous Wavelet Transforms
- Lecture 37 - Scale to Frequency
- Lecture 38 - Computational aspects of CWT
- Lecture 39 - Scalogram and MATLAB demonstration
- Lecture 40 - Scalogram and MATLAB demonstration
- Lecture 41 - Scaling function
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- Lecture 47 - Discrete Wavelet Transform
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- Lecture 49 - Orthogonal scaling function bases and MRA
- Lecture 50 - Orthogonal scaling function bases and MRA.
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- Lecture 52 - Wavelet Filters and Fast DWT Algorithm (Continued...)
- Lecture 53 - Wavelet Filters and Fast DWT Algorithm (Continued...)
- Lecture 54 - Wavelets for DWT
- Lecture 55 - Wavelets for DWT (Continued...)
- Lecture 56 - Wavelets for DWT (Continued...)
- Lecture 57 - DWT computation
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Lecture 3 - Overview of CVD Process Fundamentals

Lecture 4 - Basics of Chemical Equilibrium Calculations and Flow Dynamics

Lecture 5 - Introduction to CVD Films

Lecture 6 - Film Structure and Properties

Lecture 7 - Pressure Effects on CVD Processes

Lecture 8 - CVD of Metals

Lecture 9 - CVD of Coatings

Lecture 10 - CVD Film Property Measurements

Lecture 11 - CVD Film Property Measurements: Qualitative and Quantitative

Lecture 12 - CVD in Tungsten Filament Lamps

Lecture 13 - CVD in Tungsten Filament Lamps: Design Aspects

Lecture 14 - CVD in Hot Corrosion

Lecture 15 - CVD Transport Phenomena: Conservation Equations

Lecture 16 - CVD Transport Phenomena: Constitutive Laws

Lecture 17 - CVD Transport Phenomena: Mass Transfer Mechanisms

Lecture 18 - CVD Transport Phenomena: Mass Transfer Analogy Condition (MTAC)

Lecture 19 - CVD Transport Phenomena: Effect of Homogeneous Reactions on MTAC

Lecture 20 - CVD Applications: Hot Filament CVD (HFCVD)

Lecture 21 - CVD Applications: Aerosol CVD (ACVD)

Lecture 22 - CVD Applications: CVD of Silicon

Lecture 23 - CVD Applications: CVD in Free-Molecular Flow Regime (FMFR)

Lecture 24 - CVD Applications: CVD of nano-Structured Films

Lecture 25 - CVD Overview

Lecture 26 - Review of CVD Basics: Part-I (PDF Lecture)

Lecture 27 - Review of CVD Basics: Part-II (PDF Lecture)

Lecture 28 - CVD Question Bank (PDF Lecture)

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Lecture 30 - Basics of Nano-Structured Material Synthesis: Part-II

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[Lecture 32 - Undesirable CVD: Moolten Salt Deposition in Combustion Systems \(Adobe Presenter\)](#)

[Lecture 33 - Undesirable CVD: Hot Corrosion \(Adobe Presenter\)](#)

[Lecture 34 - Multi-component Transport Fundamentals: Assumptions and Control Volumes \(Adobe Presenter\)](#)

[Lecture 35 - Multi-component Transport Fundamentals: Mass Conservation Equations \(Adobe Presenter\)](#)

[Lecture 36 - Multi-component Transport Fundamentals: Momentum and Energy Conservation \(Adobe Presenter\)](#)

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Lecture 2 - Motivation and Introduction - Part II

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Lecture 4 - What is Chemical Engineering - Part II

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Lecture 9 - Basics of Kinetics and Contacting

Lecture 10 - Design of Batch reactors - Part I

Lecture 11 - Design of Batch reactors - Part II

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Lecture 24 - Gas Phase Homogeneous reactions

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Lecture 26 - Reactor Design for MFR and Combination of reactors

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Lecture 28 - Unsteady state MFR and PFR

Lecture 29 - Recycle Reactors

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[Lecture 59 - Direct use of RTD to predict conversion \(Macro and Micro-fluid as well as Macro & Micro-mixing Concept\) Part II](#)

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Lecture 1 - Introduction to Kinetics (Gas solid non-catalytic reaction)

Lecture 2 - Intro to Kinetics (Continued...) for catalytic reactions in different reactors

Lecture 3 - Heterogeneous rate of reactions and different types of kinetic models for non-catalytic reactions

Lecture 4 - Basics of Kinetics of type A & B reactions (Shrinking core model & Porous particle homogeneous model)

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Lecture 6 - Shrinking Core Model (Continued...)

Lecture 7 - (Continued...) & Proof of Pseudo steady state assumption

Lecture 8 - Shrinking core model (Continued...) for type D reactions

Lecture 9 - Shrinking core model (Continued...) for type D reactions (Continued...)

Lecture 10 - Reactors, Homogeneous reaction model, Design of non-catalytic gas solid reactors

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

Lecture 12 - Design of non-catalytic gas solid reactors (Continued...)

Lecture 13 - Design equation for MF of solids, uniform gas composition, const. single particle size, Shrinking core model.

Lecture 14 - Design equation for MF of solids, mixture of particles for different sizes but unchanging size, uniform gas composition, SCM

Lecture 15 - Design equation for MF of solids with elutriation, mixture of particles of different size, uniform gas composition, SCM

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

Lecture 17 - Catalytic reactions (LHHW Kinetic model)

Lecture 18 - LHHW Kinetic model (Continued...) - Part I

Lecture 19 - LHHW Kinetic model (Continued...) - Part II

Lecture 20 - Industrially important catalytic reaction models

Lecture 21 - Inter and Intraphase effectiveness factor

Lecture 22 - Interface effectiveness factor & Generalized nonisothermal effectiveness factor for external mass transfer step

Lecture 23 - Generalized nonisothermal effectiveness factor for external mass transfer step (Continued...)

Lecture 24 - Mass transfer correlations for various reactors

Lecture 25 - Isothermal intraphase effectiveness factor - Part I

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[Lecture 43 - Slurry Reactor Design](#)

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Lecture 2 - Basics of Programming using MATLAB

Lecture 3 - Array Operations in MATLAB

Lecture 4 - Loops and Execution Control

Lecture 5 - Tutorial: Using Arrays

Lecture 6 - MATLAB Files -- Scripts and Functions

Lecture 7 - Plotting and Output

Lecture 8 - How to submit MATLAB Assignment

Lecture 9 - Errors in Numerical Computation

Lecture 10 - Truncation Errors and Taylors Series

Lecture 11 - Round-Off Errors; and Iterative Methods

Lecture 12 - Step-wise Methods and Error Propagation

Lecture 13 - How to get MATLAB Online access (for all enrolled students of this course)

Lecture 14 - Differentiation in Single Variable

Lecture 15 - Higher Order Differentiation Formulae

Lecture 16 - Partial Differentials (Bonus)

Lecture 17 - Numerical Integration

Lecture 18 - Multiple Applications of Integration Formulae

Lecture 19 - In-Build MATLAB Integration Functions

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Lecture 21 - Gauss Elimination and Back-Substitution

Lecture 22 - LU Decomposition and Partial Pivoting

Lecture 23 - Gauss Siedel Method

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Lecture 30 - Using MATLAB command fsolve (multi-variable)

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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

Lecture 12 - Momentum conservation equations

Lecture 13 - Forces acting on control volume

Lecture 14 - Kinematics of deformation in fluid flow

Lecture 15 - Equations governing fluid flow in incompressible fluid

Lecture 16 - Navier-Stokes equation for simple cases of flow

Lecture 17 - Energy conservation equations

Lecture 18 - Practical cases of fluid flow with heat transfer in CFD point of view

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Lecture 20 - Equations governing fluid flow with chemical reactions

Lecture 21 - Concept of wellposedness of mathematical problems

Lecture 22 - Introduction to finite difference methods

Lecture 23 - Finite difference approximation on a uniform mesh

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Lecture 25 - Solution of Poisson equation in rectangular duct-Tutorial

Lecture 26 - Discretization of time domain

Lecture 27 - FD approx. on a non-uniform mesh and need of analysis of obtained discretization

Lecture 28 - Need for the analysis of discretized equation

Lecture 29 - Properties of Numerical Schemes: Accuracy, Conservation property, Boundedness, Consistency, Stability and Convergence

Lecture 30 - Properties of Numerical Schemes: Stability analysis

Lecture 31 - Tutorial on Stability Analysis

Lecture 32 - Analysis of Generic 1-d scalar transport equation

Lecture 33 - Introduction to the solution of coupled N-S equations

Lecture 34 - N-S equation in compressible flow- Mac Cormack Scheme

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Lecture 36 - Implicit Beam-Warming Scheme

Lecture 37 - Compressible flow to Incompressible flow

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Lecture 39 - Artificial compressibility method, Stream function-vorticity method

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Lecture 41 - Pressure Correction Method

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Lecture 58 - The Advancing Front Method continuation

Lecture 59 - Time and length scale of turbulence

Lecture 60 - The turbulent closure problem

Lecture 61 - The generic formulation for turbulence

Lecture 62 - More generic formulation and summary

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Lecture 8 - Statistics for Variance and Proportion

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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 8 - Weak intermolecular forces : What, Where, When and How?

Lecture 9 - Weak intermolecular forces : What, Where, When and How?

Lecture 10 - Weak intermolecular forces : What, Where, When and How?

Lecture 11 - Weak intermolecular forces : What, Where, When and How?

Lecture 12 - Weak intermolecular forces : What, Where, When and How?

Lecture 13 - Chemistry concepts of Immediate relevance - Part 1

Lecture 14 - Chemistry concepts of Immediate relevance - Part 2

Lecture 15 - Chemistry concepts of Immediate relevance - Part 3

Lecture 16 - Chemistry concepts of Immediate relevance - Part 4

Lecture 17 - Chemistry concepts of Immediate relevance - Part 5

Lecture 18 - Chemistry concepts of Immediate relevance - Part 6

Lecture 19 - Chemistry concepts of Immediate relevance - Part 7

Lecture 20 - Molecular recognition - Part 1

Lecture 21 - Molecular recognition - Part 2

Lecture 22 - Molecular recognition - Part 3

Lecture 23 - Molecular recognition - Part 4

Lecture 24 - Molecular recognition - Part 5

Lecture 25 - Molecular recognition - Part 6

Lecture 26 - Molecular recognition - Part 7

Lecture 27 - Molecular recognition - Part 8

Lecture 28 - Molecular recognition - Part 9

Lecture 29 - Molecular recognition - Part 10

Lecture 30 - Property driven functions of Supramolecular assembly

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[Lecture 32](#)

[Lecture 33 - Metal coordinated architectures](#)

[Lecture 34 - Engineering Supramolecular devices : Sensors,Switches,Devices and Molecules - Part 1](#)

[Lecture 35 - Engineering Supramolecular devices : Sensors,Switches,Devices and Molecules - Part 2](#)

[Lecture 36 - Engineering Supramolecular devices : Sensors,Switches,Devices and Molecules - Part 3](#)

[Lecture 37 - Engineering Supramolecular devices : Sensors,Switches,Devices and Molecules - Part 4](#)

[Lecture 38 - Engineering Supramolecular devices : Sensors,Switches,Devices and Molecules - Part 5](#)

[Lecture 39 - Engineering Supramolecular devices : Sensors,Switches,Devices and Molecules - Part 6](#)

[Lecture 40 - From molecules to machines : A glimpse at the travel](#)

- Lecture 1 - Introduction to oil and gas
- Lecture 2 - Drilling and Completion
- Lecture 3 - Well completion
- Lecture 4 - Oil and gas production systems
- Lecture 5 - Pumps, compressors and flow through pipes
- Lecture 6 - Reservoir fluid
- Lecture 7 - Fluid properties and Phase diagram - Part 1
- Lecture 8 - Fluid properties and Phase diagram - Part 2
- Lecture 9 - Nodal analysis
- Lecture 10 - Reservoir deliverability - Single phase flow
- Lecture 11 - Reservoir deliverability - Two phase flow
- Lecture 12 - Flow over a flat surface or flow through pipe - Part 1
- Lecture 13 - Flow over a flat surface or flow through pipe - Part 2
- Lecture 14 - Single-Phase, Multi-Phase-Emulsion
- Lecture 15 - Emulsification and demulsification
- Lecture 16 - Single and Multi Phase flow-flow regimes
- Lecture 17 - Multi phase flow-flow models
- Lecture 18 - Choke Performance
- Lecture 19 - Pump classifications
- Lecture 20 - Classification of artificial lifts - Part 1
- Lecture 21 - Classification of artificial lifts - Part 2
- Lecture 22 - Sucker rod pump (SRP) - Part 1
- Lecture 23 - Sucker rod pump (SRP) - Part 2
- Lecture 24 - Sucker rod pump (SRP) - Part 3
- Lecture 25 - Sucker rod pump (SRP) - Part 4
- Lecture 26 - Sucker rod pump (SRP) - Part 5
- Lecture 27 - Sucker rod pump (SRP) - Part 6
- Lecture 28 - SRP-Pump performance analysis - Part 1
- Lecture 29 - SRP-Pump performance analysis - Part 2
- Lecture 30 - SRP-Pump performance analysis - Part 3
- Lecture 31 - Introduction to progressive cavity pump

[Lecture 32 - Progressive cavity Pump - Part 1](#)

[Lecture 33 - Progressive cavity Pump - Part 2](#)

[Lecture 34 - Progressive cavity Pump - Part 3](#)

[Lecture 35 - Progressive cavity Pump - Part 4](#)

[Lecture 36 - Progressive cavity Pump - Part 5](#)

[Lecture 37 - Electric submersible pump - Part 1](#)

[Lecture 38 - Electric submersible pump - Part 2](#)

[Lecture 39 - Electric submersible pump - Part 3](#)

[Lecture 40 - ESP- basic electrical systems - Part 1](#)

[Lecture 41 - ESP- basic electrical systems - Part 2](#)

[Lecture 42 - ESP- basic electrical systems - Part 3](#)

[Lecture 43 - ESP- numerical problems - Part 1](#)

[Lecture 44 - ESP- numerical problems - Part 2](#)

[Lecture 45 - ESP- numerical problems - Part 3](#)

[Lecture 46 - ESP- numerical problems - Part 1](#)

[Lecture 47 - ESP- numerical problems - Part 2](#)

[Lecture 48 - Gas lift basics - Part 1](#)

[Lecture 49 - Gas lift basics - Part 2](#)

[Lecture 50 - Gas lift valves and installartion - Part 1](#)

[Lecture 51 - Gas lift valves and installartion - Part 2](#)

[Lecture 52 - Plunger lift and design](#)

[Lecture 53 - Hydraulic jet pump fundamentals - Part 1](#)

[Lecture 54 - Hydraulic jet pump fundamentals - Part 2](#)

[Lecture 55 - Hydraulic engine pumps and design - Part 1](#)

[Lecture 56 - Hydraulic engine pumps and design - Part 2](#)

[Lecture 57 - Surface pump units for jet pump - Part 1](#)

[Lecture 58 - Surface pump units for jet pump - Part 2](#)

[Lecture 59 - Surface pump units for jet pump - Part 3](#)

[Lecture 60 - Surface compressor for gas lift - Part 1](#)

[Lecture 61 - Surface compressor for gas lift - Part 2](#)

[Lecture 62 - Surface compressor for gas lift - Part 3](#)



Lecture 1 - Introduction to interfaces

Lecture 2 - Importance of surface; Application of interfaces

Lecture 3 - Basics of classical and emerging tools

Lecture 4 - Concepts of capillarity and surface tension (ST) and measurement of ST and contact angle

Lecture 5 - Overview of various surface tension measurement techniques

Lecture 6 - Young-Dupre equation; Tutorial

Lecture 7 - Young-Laplace equation; Tutorial

Lecture 8 - Kelvin equation; Tutorial

Lecture 9 - Contact angle for ideal and non-ideal cases; Application of Young-Dupre

Lecture 10 - Measurement of contact angle of surfaces at fluid-fluid interfaces

Lecture 11 - Washburn approach; Tutorial

Lecture 12 - Work of cohesion, adhesion, and spreading coefficient

Lecture 13 - Girifalco-Good Fowkes equation; Tutorial

Lecture 14 - Demonstration of force tensiometer

Lecture 15 - Demonstration of optical tensiometer

Lecture 16 - Shapes of micelles, critical micelle concentration (CMC); critical packing parameter (CPP)

Lecture 17 - Thermodynamic principles of self-assembly

Lecture 18 - Micellar-enhanced ultrafiltration (MEUF): A surfactant-based separation technique

Lecture 19 - HLB guidelines; Debye plot

Lecture 20 - Surface excess concepts and problem solving

Lecture 21 - Gibbs adsorption isotherm equation

Lecture 22 - Deposition of Langmuir Blodgett (LB) films; Adsorption from solution

Lecture 23 - Demonstration of double barrier LB deposition technique

Lecture 24 - Emulsion and microemulsion; Application of microemulsion

Lecture 25 - Demonstration of emulsification using several emulsifying devices

Lecture 26 - Demonstration of particle size analyzer

Lecture 27 - Demonstration of particle/droplet tracking using an inverted microscope

Lecture 28 - Introduction to colloids

Lecture 29 - Understanding Intermolecular forces

Lecture 30 - van der Waals force

Lecture 31 - Lifshitz approach

[Lecture 32 - Electrical double layer \(EDL\) interaction \(Helmholtz\)](#)

[Lecture 33 - Gouy-Chapman EDL Model](#)

[Lecture 34 - Gouy-Chapman-Stern EDL model](#)

[Lecture 35 - Overlapping double layer interaction](#)

[Lecture 36 - Derjaguin approximation; DLVO forces of interactions](#)

[Lecture 37 - Force-measuring techniques: Direct and indirect measurements](#)

[Lecture 38 - Steric \(Polymer-mediated\) forces](#)

[Lecture 39 - Electrokinetic phenomena](#)

[Lecture 40 - Demonstration of zeta potential measurements](#)

Lecture 1 - Introduction and Need for this course

Lecture 2 - Learning Objectives and schedule

Lecture 3 - Sectors of Chemical Industry

Lecture 4 - Understanding cost by Engineers

Lecture 5 - Investment Cost

Lecture 6 - Understanding Financial Performance of Companies

Lecture 7 - Global perspective of Chemical Industry

Lecture 8 - Nature and Development of Indian Chemical Industry

Lecture 9 - Research, Tech development and Licensing

Lecture 10 - Guest lecturer on skill development

Lecture 11 - Technology Development Process

Lecture 12 - Technology Readiness Level

Lecture 13 - Evolution of Technology - Caustic soda example

Lecture 14 - Evolution of Technology - Caustic soda example

Lecture 15 - Case study of heat recovery

Lecture 16 - Case study of Tech development- auto thermal gasification

Lecture 17 - Guidelines on choosing and completing a project report on Technology Development

Lecture 18 - Guidelines on choosing and completing a project report

Lecture 19 - Example of a case study of an affordable potable water drinking technology described in detail

Lecture 20 - Example of potable water technology through desalination of sea water

Lecture 21 - Case study of manufacturing of Polysilicon in India as a example of Technology Development

Lecture 22 - Case study of manufacturing of Polysilicon in India as a example of Technology Development (Continued...)

Lecture 23 - Industrial R&D ecosystem in India

Lecture 24 - Technology Transfer - prospects and challenges

Lecture 25 - Guidelines on choosing and completing a project report

Lecture 26 - Jobs and career options in Industry

Lecture 27 - Continuation of Jobs and career options in Industry

Lecture 28 - Application of Taguchi Quality Function analysis to industrial processes

Lecture 29 - Course review and Introduction to Taguchi Quality Function Development

Lecture 30 - Preparing for Job interviews

Lecture 1 - Introduction to Chemical process Industries

Lecture 2 - Raw material for Organic Chemical Industries

Lecture 3 - Unit processes and unit operations in organic chemical Industries

Lecture 4 - Coal and coal as chemicals feed stock

Lecture 5 - Coal carbonization and Coke oven plant

Lecture 6 - Gasification of Coal,Petrocoke and Biomass

Lecture 7 - Introduction to Pulp and paper Industry, Raw material for paper industry and Technological development

Lecture 8 - Pulping and Bleaching

Lecture 9 - Recovery of Chemicals

Lecture 10 - Stock preparation and paper making

Lecture 11 - Introduction to Soap and detergent, Soap making and Recovery of Glycerine

Lecture 12 - Synthetic detergent and Linear alkyl benzene

Lecture 13 - Sugar and Fermentation industry

Lecture 14 - Ethanol as Biofuel and Chemical feed stock

Lecture 15 - Introduction : Staus of Petroleum refinery, Crude oil and Natural gas origin, occurrence, exploration, drilling and processing, Fuel norms

Lecture 16 - Evaluation of Crude oil,Petroleum Products and Apetrochemicals

Lecture 17 - Crude oil Distillation

Lecture 18 - Thermal Cracking: Visbreaking and Delayed Coking

Lecture 19 - Catalytic cracking: Fluid Catalytic cracking and Hydro cracking

Lecture 20 - Catalytic reforming

Lecture 21 - Alkylation, Isomerisation and Polymerisation

Lecture 22 - Desulphurisation Processes and Recovery of Sulphur

Lecture 23 - Profile of petrochemical Industry and its structure

Lecture 24 - Naphtha and gas cracking for production of olefins

Lecture 25 - Recovery of chemicals from FCC and steam cracking

Lecture 26 - Synthesis gas and its derivatives: Hydrogen, CO, Methanol, Formaldehyde

Lecture 27 - Ethylene derivatives: Ethylene Oxide, Ethylene glycol, Ethylene dichloride and Vinyl chloride

Lecture 28 - Propylene, Propylene oxide and Isopropanol

Lecture 29 - Aromatics Production

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

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

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  $\hat{I}^*_{t \min}$

Lecture 20 - Global & stream specific  $\hat{I}^*_{t \min}$  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 Characterization 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

- 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

Lecture 28 - Economizer, Super heaters, and Safety devices

Lecture 29

Lecture 30 - Insulation of Steam Generators

Lecture 31 - Air

- Lecture 32 - Air Filtration and Pneumatic Conveying
- Lecture 33 - Introduction to Pneumatic Conveying System
- Lecture 34 - Conveying System Types
- Lecture 35 - Material Properties and Pipeline Feeding Devices
- Lecture 36 - Feeding devices
- Lecture 37 - Gas-solid flows
- Lecture 38 - Design of Pipelines Elements of Pipeline Design
- Lecture 39 - Natural Gas Transmission - I
- Lecture 40 - Natural Gas Transmission - II
- Lecture 41 - Natural Gas Transmission - III
- Lecture 42 - Pipeline Mechanical design - Natural Gas Transmission - IV
- Lecture 43 - Cooling Tower; Theory and Some Basic Calculations
- Lecture 44 - Concept of Heat Transfer in Cooling Tower and its Components
- Lecture 45 - Types and Components of Cooling Tower
- Lecture 46 - Components and Materials of Construction and Applications of Cooling Tower
- Lecture 47 - Control and Maintenance in cooling towers
- Lecture 48 - Pressure Levels and Terminology - I
- Lecture 49 - Pressure Levels and Terminology - II
- Lecture 50 - Gauges for Pressure Measurement
- Lecture 51 - Refrigerants and Refrigeration
- Lecture 52 - Introduction to Refrigeration
- Lecture 53 - Refrigeration System Components
- Lecture 54 - Refrigeration System Components and Refrigeration Cycle
- Lecture 55 - Refrigeration Systems
- Lecture 56 - Refractories
- Lecture 57 - Thermodynamic Principles and Corrosion in Refractories
- Lecture 58 - Slag Attack and Kinds of Refractories in Uses
- Lecture 59 - Brief history of Insulations and its fundamental principles
- Lecture 60 - Heat transfer in Insulations materials

Lecture 1 - Introduction to Water Pollution and Control

Lecture 2 - Environmental Acts and Standards

Lecture 3 - Water Quality Monitoring: Physical Parameters

Lecture 4 - Water Quality Monitoring: Physical and Chemical Parameters

Lecture 5 - Water Quality Monitoring: Chemical Parameters - I

Lecture 6 - Water Quality Monitoring: Chemical Parameters - II

Lecture 7 - Water Quality Monitoring: Biological/Biochemical Parameters - I

Lecture 8 - Water Quality Monitoring: Biological/Biochemical Parameters - II

Lecture 9 - Water Quality Monitoring: Bacteriological Parameters

Lecture 10 - Treatment of Water and Wastewater

Lecture 11 - Flow Equalization

Lecture 12 - Aeration - I

Lecture 13 - Aeration - II

Lecture 14 - Aeration - III

Lecture 15 - Aeration - IV

Lecture 16 - Aeration - V

Lecture 17 - Aeration - VI

Lecture 18 - Coagulation and Flocculation - I

Lecture 19 - Coagulation and Flocculation - II

Lecture 20 - Coagulation and Flocculation - III

Lecture 21 - Coagulation and Flocculation - IV

Lecture 22 - Settling and Sedimentation - I

Lecture 23 - Settling and Sedimentation - II

Lecture 24 - Settling and Sedimentation - III

Lecture 25 - Settling and Sedimentation - IV

Lecture 26 - Settling and Sedimentation - V

Lecture 27 - Settling and Sedimentation - VI

Lecture 28 - Filtration - I

Lecture 29 - Filtration - II

Lecture 30 - Filtration - III

Lecture 31 - Adsorption - I

- Lecture 32 - Adsorption - II
- Lecture 33 - Adsorption - III
- Lecture 34 - Adsorption - IV
- Lecture 35 - Adsorption - V
- Lecture 36 - Adsorption - VI
- Lecture 37 - Ion-exchange - I
- Lecture 38 - Ion-exchange - II
- Lecture 39 - Ion-exchange - III
- Lecture 40 - Ion-exchange - IV
- Lecture 41 - Wastewater treatment by membrane processes - I
- Lecture 42 - Wastewater treatment by membrane processes - II
- Lecture 43 - Wastewater treatment by membrane processes - III
- Lecture 44 - Wastewater treatment by membrane processes - IV
- Lecture 45 - Wastewater treatment by membrane processes - V
- Lecture 46 - Advanced Oxidation Processes (AOP) - Introduction
- Lecture 47 - AOP - Photocatalytic wastewater treatment
- Lecture 48 - AOP - Fenton, ozone and catalytic treatment
- Lecture 49 - AOP - Electrochemical wastewater treatment - I
- Lecture 50 - AOP - Electrochemical wastewater treatment - II
- Lecture 51 - AOP - Sono-hybrid wastewater treatment
- Lecture 52 - Disinfection - I
- Lecture 53 - Disinfection - II
- Lecture 54 - Disinfection - III
- Lecture 55 - Case Study - Wastewater treatment in sugar industry
- Lecture 56 - Case Study - Wastewater treatment in distillery
- Lecture 57 - Case Study - Wastewater treatment in fertilizer industry
- Lecture 58 - Case Study - Wastewater treatment in petroleum refining industry
- Lecture 59 - Case Study - Common effluent treatment plant (CETP)
- Lecture 60 - Choice of technology and summary

Lecture 1 - Introduction

Lecture 2 - Ecology, Environment and Biodiversity

Lecture 3 - Ecosystem services and its risks - 1

Lecture 4 - Ecosystem services and its risks - 2

Lecture 5 - Tutorial-1

Lecture 6 - Pollution types and sources

Lecture 7 - Pollution: Impacts/Consequences

Lecture 8 - Transmission of pollutants in environment - 1

Lecture 9 - Transmission of pollutants in environment - 2

Lecture 10 - Tutorial-2

Lecture 11 - Environmental quality and standards - 1

Lecture 12 - Environmental quality and standards - 2

Lecture 13 - Instrumental techniques of environmental analysis - 1

Lecture 14 - Instrumental techniques of environmental analysis - 2

Lecture 15 - Tutorial-3

Lecture 16 - Sampling and characterization - 1 (Gas, air ,emission)

Lecture 17 - Sampling and characterization - 2 (water, wastewater, effluents)

Lecture 18 - Sampling and characterization - 3 (solid waste and soil)

Lecture 19 - Environmental laws and regulatory framework

Lecture 20 - Tutorial-4

Lecture 21 - Air pollution control - 1

Lecture 22 - Air pollution control - 2

Lecture 23 - Air pollution control - 3

Lecture 24 - Air pollution control - 4

Lecture 25 - Tutorial-5

Lecture 26 - Treatment of surface and ground water for drinking water generation

Lecture 27 - Treatment of domestic and industrial wastewater: Schemes

Lecture 28 - Primary treatment equipment

Lecture 29 - Secondary treatment processes

Lecture 30 - Tutorial-6

Lecture 31 - Secondary treatment equipment - 1

Lecture 32 - Secondary treatment equipment - 2

Lecture 33 - Advanced secondary processes - 1

Lecture 34 - Advanced secondary processes - 2

Lecture 35 - Tutorial-7

Lecture 36 - Advanced secondary processes - 3

Lecture 37 - Tertiary treatment - 1

Lecture 38 - Tertiary treatment - 2

Lecture 39 - Tertiary treatment - 3

Lecture 40 - Tutorial-8

Lecture 41 - Sludge management - 1

Lecture 42 - Sludge management - 2

Lecture 43 - Sludge management - 3

Lecture 44 - Industrial Pollution Control in GPI - 1 (General aspect and pollution control in sugar industry)

Lecture 45 - Tutorial-9

Lecture 46 - Industrial Pollution Control in GPI - 2 (Pollution control in Distillery)

Lecture 47 - Industrial Pollution Control in GPI - 3 (Pollution control in Tannery)

Lecture 48 - Pollution control in Petroleum refinery and petrochemicals industry

Lecture 49 - Industrial Pollution Control in GPI - 4

Lecture 50 - Tutorial 10

Lecture 51 - Solid waste and hazardous waste management - 1

Lecture 52 - Solid waste and hazardous waste management - 2

Lecture 53 - Solid waste and hazardous waste management - 3

Lecture 54 - Solid waste and hazardous waste management - 4

Lecture 55 - Tutorial-11

Lecture 56 - Air Pollution Management, Air quality survey, NAAQI - 1

Lecture 57 - Air Pollution Management, Air quality survey, NAAQI - 2

Lecture 58 - Management of special category wastes - 1

Lecture 59 - Management of special category wastes - 2

Lecture 60 - Tutorial-12

Lecture 1 - Introduction to Biological Process Design for Wastewater Treatment

Lecture 2 - Microorganisms in Biological Wastewater Treatment

Lecture 3 - Fundamentals of Biochemical Operations

Lecture 4 - Wastewater Characterization - I

Lecture 5 - Wastewater Characterization - II

Lecture 6 - Wastewater Characterization - III

Lecture 7 - Wastewater Characterization - IV

Lecture 8 - Wastewater Characterization - V

Lecture 9 - Stoichiometry of Microbial Growth - I

Lecture 10 - Stoichiometry of Microbial Growth - II

Lecture 11 - Stoichiometry of Microbial Growth - III

Lecture 12 - Reaction Kinetics

Lecture 13 - Bacterial Growth Kinetics - I

Lecture 14 - Bacterial Growth Kinetics - II

Lecture 15 - Reactor Hydraulics - I

Lecture 16 - Reactor Hydraulics - II

Lecture 17 - Treatment of Water and Wastewater - I

Lecture 18 - Treatment of Water and Wastewater - II

Lecture 19 - Coagulation, Flocculation, and Sedimentation - I

Lecture 20 - Coagulation, Flocculation, and Sedimentation - II

Lecture 21 - Lagoon

Lecture 22 - Activated Sludge Process

Lecture 23 - Sequential Batch Reactor

Lecture 24 - Trickling Filter

Lecture 25 - Rotating Disc Reactor

Lecture 26 - Up-flow Anaerobic Sludge Blanket (UASB) reactor

Lecture 27 - UASB and Biotower

Lecture 28 - Advanced Biological Wastewater Treatment: Fluidized Bed Bioreactors

Lecture 29 - Advanced Biological Wastewater Treatment: Membrane Bioreactors

Lecture 30 - Advanced Biological Wastewater Treatment: Moving Bed Biofilm Reactor (MBBR)

Lecture 31 - Sludge Management - I

[Lecture 32 - Sludge Management - II](#)

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[Lecture 34 - Sludge Management - IV](#)

[Lecture 35 - Sludge Management - V](#)

[Lecture 36 - Sludge Management - VI](#)

[Lecture 37 - Sustainable Development and Environmental Impact Assessment](#)

[Lecture 38 - Management of Wastewater from Dairy Industry](#)

[Lecture 39 - Management of Wastewater from Slaughterhouse](#)

[Lecture 40 - Common Effluent Treatment Plant \(CETP\)](#)



Lecture 1 - Introduction

Lecture 2 - Introduction\_Various Reactors\_BR

Lecture 3 - Design Equation\_Continuous reactor (CSTR\_PFR\_PBR)

Lecture 4 - Design Equation\_Continuous reactor (CSTR\_PFR\_PBR)\_Sizing

Lecture 5 - Reaction Rate with Conversion, Temperature, and pressure (Batch/Flow system)

Lecture 6 - Space time Space velocity and CSTRs in series/parallel

Lecture 7 - Effect of Pressure Drop on reactor design (PBR)\_(X vs W) and (P vs W)

Lecture 8 - Effect of Pressure Drop on Reactor design (PBR)\_(X vs W)\_(P vs W)

Lecture 9 - Effect of Pressure Drop in PBR reactor\_Analytical solution of Differential equation

Lecture 10 - Effect of Pressure Drop in PBR reactor\_Analytical solution for Reaction With Pressure drop

Lecture 11 - Effect of Pressure Drop in PBR reactor\_Example

Lecture 12 - Differential Reactor\_rate of reaction\_catalyst deactivation

Lecture 13 - Catalyst deactivation

Lecture 14 - Catalyst Deactivation\_Temperature (T) - Time (t) trajectories

Lecture 15 - Moving Bed Reactor\_Catalyst deactivation

Lecture 16 - STTR\_Catalyst deactivation

Lecture 17 - Multi phase reactors-1: Slurry reactor - 1

Lecture 18 - Multi phase reactors-1: Slurry reactor - 2

Lecture 19 - Multi phase reactors-1: Slurry reactor - 3

Lecture 20 - Multi phase reactors-2: Trickle bed reactor - 1

Lecture 21 - Multi phase reactors-2: Trickle bed reactor - 2

Lecture 22 - Multi phase reactors-2: Trickle bed reactor - 3

Lecture 23 - Bioreactor\_Cell Growth and Rate laws

Lecture 24 - Bioreactors\_Stoichiometry\_Yield coefficients\_rate of substrate consumption

Lecture 25 - Bioreactors\_Example\_Yield coefficients and rate law parameters estimation

Lecture 26 - Bioreactors\_Mass Balances (Cell, Substrate, Product)

Lecture 27 - Bioreactors\_Chemostats

Lecture 28 - Steady State Non Isothermal reactor design\_EB equation

Lecture 29 - Steady State Non Isothermal reactor design\_Example

Lecture 30 - SS Non Isothermal reactor design\_Reaction with Heat Exchange

Lecture 31 - SS Non Isothermal reactor design\_Heat Exchange\_T-profile for a few cases

- Lecture 32 - SS Non Isothermal reactor design\_Equilibrium conversion
- Lecture 33 - SS Non Isothermal reactor design\_Optimum feed temperature
- Lecture 34 - SS Non Isothermal reactor design\_Multiple Steady States
- Lecture 35 - SS Non Isothermal reactor design\_Ignition Extinction Curves
- Lecture 36 - SS Non Isothermal reactor design\_Runaway reaction in a CSTR
- Lecture 37 - SS Non Isothermal reactor design\_Energy Balance:Multiple rxn in a CSTR/PFR (Examples)
- Lecture 38 - Non-ideal flow - 1
- Lecture 39 - Basics of Non-ideal flow - 2
- Lecture 40 - Basics of Non-ideal flow - 3
- Lecture 41 - Non-ideal flow-Segregation model
- Lecture 42 - One parameter Model-Tank in Series model (TIS)
- Lecture 43 - Non-ideal flow-Dispersion model - Part 1
- Lecture 44 - Non-ideal flow-Dispersion model - Part 2
- Lecture 45 - Non-ideal flow-Dispersion model - Part 3
- Lecture 46 - Two parameter Models-Modeling real reactors with Combinations of Ideal Reactors
- Lecture 47 - Solid Catalyzed Reaction: Reaction and Diffusion - Part 1
- Lecture 48 - Solid Catalyzed Reaction: Reaction and Diffusion - Part 2
- Lecture 49 - Solid Catalyzed Reaction: Reaction and Diffusion - Part 3
- Lecture 50 - Catalysis and Catalytic Reactors - Part 1
- Lecture 51 - Catalysis and Catalytic Reactors - Part 2
- Lecture 52 - Catalysis and Catalytic Reactors - Part 3
- Lecture 53 - Collection and Analysis of Rate - Part 1
- Lecture 54 - Collection and Analysis of Rate - Part 2
- Lecture 55 - Collection and Analysis of Rate - Part 3
- Lecture 56 - Polymath and ODE solver
- Lecture 57 - Catalyst Synthesis - Part 1
- Lecture 58 - Catalyst Synthesis - Part 2
- Lecture 59 - Catalyst Characterization Techniques: BET, Pore size, Pore volume
- Lecture 60 - Catalyst Characterization Techniques

Lecture 1 - Introduction to Polymers

Lecture 2 - Polymers and Polymerization Techniques

Lecture 3 - Characteristics of Polymers - I

Lecture 4 - Characteristics of Polymers - II

Lecture 5 - Applications of Polymers

Lecture 6 - Thermodynamics of Polymer Systems - I

Lecture 7 - Thermodynamics of Polymer Systems - II

Lecture 8 - Thermodynamics of Polymer Systems - III

Lecture 9 - Thermodynamics of Polymer Systems - IV

Lecture 10 - Thermodynamics of Polymer Systems - V

Lecture 11 - Applied polymer rheology: Fluid behavior

Lecture 12 - Applied polymer rheology: Structure and properties of deforming polymer

Lecture 13 - Applied polymer rheology: Flow of polymers with supermolecular structure

Lecture 14 - Applied polymer rheology: Transport phenomena

Lecture 15 - Applied polymer rheology: Rheometry

Lecture 16 - Heat Transfer Phenomenon in polymer systems: Introduction

Lecture 17 - Heat Transfer Phenomenon in polymer systems: Thermal properties

Lecture 18 - Heat Transfer Phenomenon in polymer systems: Thermal properties and conduction

Lecture 19 - Heat Transfer Phenomenon in polymer systems: Conduction and Convection

Lecture 20 - Heat Transfer Phenomenon in polymer systems: Convection and Radiation

Lecture 21 - Mass Transfer Phenomenon in Polymers: Introduction

Lecture 22 - Steady State Diffusion in Polymers

Lecture 23 - Mass transfer coefficient and dimensionless numbers

Lecture 24 - Mass transfer phenomenon in polymers: Laminar flow and boundary layer conditions

Lecture 25 - Mass transfer phenomenon in polymers: Diffusivity and solubility of gases

Lecture 26 - Chemical reaction engineering in polymers: Introduction

Lecture 27 - Chemical reaction engineering in polymers: Condensation (Step-growth) polymerization

Lecture 28 - Chemical reaction engineering in polymers: Addition (Chain-Growth) Polymerization - I

Lecture 29 - Chemical reaction engineering in polymers: Addition (Chain-Growth) Polymerization - II

Lecture 30 - Chemical reaction engineering in polymers: Addition (Chain-Growth) Polymerization - III

Lecture 31 - Injection Moulding - 1

Lecture 32 - Injection Moulding - 2

Lecture 33 - Extrusion

Lecture 34 - Blow moulding

Lecture 35 - Calendaring and Fiber spinning

Lecture 36 - Polymer Testing - 1

Lecture 37 - Polymer testing - 2 (Standardization, Sample preparation)

Lecture 38 - Polymer testing - 3

Lecture 39 - Polymer testing - 4 (Measuring of rheological properties)

Lecture 40 - Polymer testing - 5 (Mechanical properties; Hardness, tensile and compression)

Lecture 41 - Polymer testing - 6

Lecture 42 - Polymer Testing - 7

Lecture 43 - Polymer Testing - 8

Lecture 44 - Polymer Testing - 9

Lecture 45 - Polymer Testing - 10

Lecture 46 - Polymeric Materials Used in Electronics

Lecture 47 - Polymers in Electronics: Epoxies

Lecture 48 - Epoxies, Phenoxies, and Silicones

Lecture 49 - Polyimides

Lecture 50 - Fluorocarbons, Polyxylyenes, and Polyesters

Lecture 51 - Polymer Materials in Electronics

Lecture 52 - Functions of Coatings - I

Lecture 53 - Functions of Coatings - II

Lecture 54 - Natural fibers reinforced composites - I

Lecture 55 - Natural fibers reinforced composites - II

Lecture 56 - NFRCs and Polymer Applications

Lecture 57 - Polymer Applications in Building Materials

Lecture 58 - Polymer applications in different fields: Polymer in textile

Lecture 59 - Polymer applications in different fields: Polymer in cosmetics

Lecture 60 - Polymer applications in different fields: Polymer and food packaging

**NPTEL : Chemical Reaction Engineering (Chemical Engineering)**

**Co-ordinators : Prof. Jayant M Modak**

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Lecture 2 - Basic concepts : Representation of Chemical Reactions

Lecture 3 - Thermodynamics of Chemical Reactions - Part I

Lecture 4 - Thermodynamics of Chemical Reactions - Part II

Lecture 5 - Chemical Reaction Kinetics - Overview

Lecture 6 - Chemical Reaction Kinetics & Reactor Design

Lecture 7 - Chemical Reactor Design

Lecture 8 - Problem Solving: Thermodynamics & Kinetics

Lecture 9 - Complex Reactions - Introduction

Lecture 10 - Complex Reactions - Yield & Selectivity

Lecture 11 - Complex Reactions - Quasi Steady State and Quasi Equilibrium Approximations

Lecture 12 - Complex Reactions - Kinetics of Chain Reactions & polymerization

Lecture 13 - Catalytic reactions - Introduction

Lecture 14 - Catalytic reactions - Adsorption & Desorption

Lecture 15 - Catalytic reactions - Kinetics

Lecture 16 - Monomolecular Reaction Network & Lumping Analysis

Lecture 17 - Problem solving: Complex reactions

Lecture 18 - Gas-solid Catalytic Reactions - External diffusion

Lecture 19 - Gas-solid Catalytic Reactions - Transport in Catalyst Pellet

Lecture 20 - Gas-solid Catalytic Reactions - Diffusion & Reaction - I

Lecture 21 - Gas-solid Catalytic Reactions - Diffusion & Reaction - II

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