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

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

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

Lecture 1 - Stirling's Approximation

Lecture 2 - Fourier Transforms and characteristic function

Lecture 3 - Dirac Delta function

Lecture 4 - Applications of delta function and Generating functions

Lecture 5 - Laplace Transforms and Convolution theorem

Lecture 6 - Generating function for discrete variables and Binomial distribution

Lecture 7 - Bernoulli and Poisson distributions

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

Lecture 9 - Introduction to Central Limit Theorem

Lecture 10 - Proof of Central Limit Theorem (CLT)

Lecture 11 - Universality of Normal distribution and Exceptions

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

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

Lecture 14 - Characteristics of Stochastic Phenomena: Markov Processes

Lecture 15 - Propagating Markov processes via Transition Probability Matrix with

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

Lecture 17 - Transient solutions and Continuous time Markov process

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

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

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

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

Lecture 22 - Generalized Random Walk with Bias and Pausing

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

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

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

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

Lecture 27 - Random Walk with Bias and Absorber

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

Lecture 29 - Introduction to gambler's ruin problem

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

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

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

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

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

Lecture 1 - General Introduction Definitions

Lecture 2 - General Introduction, Definitions, Surface Tension

Lecture 3 - Surface Tension Free Energies and Adsorption

Lecture 4 - Properties over Curved Surfaces

Lecture 5 - Total Surface Energy

Lecture 6 - Interfacial Tension Entropy, Cohesion, Adhesion

Lecture 7 - Cohesion, Adhesion and Spreading

Lecture 8 - Spreading from Liquids and Solids

Lecture 9 - Spreading, Interfacial Tensions, Surface Tensions

Lecture 10 - Spreading, Contact Angles Free Energies

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

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

Lecture 13 - Work of Adhesion, Surface and Interfacial Tensions

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

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

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

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

Lecture 18 - Surface and Interfacial Potentials Distribution and Contact Potentials

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

Lecture 20 - Electrically Charged Monolayers Gouy Theory

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

Lecture 22 - Condensed and Liquid Expanded Monolayers Phase Transformations

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

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

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

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

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

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

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

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

Lactonization

Lecture 31 - Catalytic Effects Reactions in Emulsions Complex Formation

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

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

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

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

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

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

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Lecture 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

- 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

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- Lecture 2 - Molecular Diffusion
- Lecture 3 - Fick's Law of Diffusion
- Lecture 4 - Steady state molecular diffusion in fluids - Part I
- Lecture 5 - Steady state molecular diffusion in fluids - Part II
- Lecture 6 - Diffusion coefficient: Measurement and Prediction - Part I
- Lecture 7 - Diffusion Coefficient: Measurement and Prediction - Part II
- Lecture 8 - Multicomponent Diffusion and Diffusivity in Solids
- Lecture 9 - Concept of Mass Transfer Coefficient
- Lecture 10 - Dimensionless Groups and Co-relations for Convective
- Lecture 11 - Mass Transfer co-efficient in Laminar Flow Condition
- Lecture 12 - Boundary Layer Theory and Film Theory in Mass Transfer
- Lecture 13 - Mass Transfer Coefficients in Turbulent Flow
- Lecture 14 - Interphase Mass Transfer and Mass Transfer Theories - Part I
- Lecture 15 - Interphase Mass Transfer and Mass Transfer Theories - Part II
- Lecture 16 - Interphase Mass Transfer and Mass Transfer Theories - Part III
- Lecture 17 - Agitated and Sparged Vessels
- Lecture 18 - Tray Column - Part I
- Lecture 19 - Tray Column - Part II
- Lecture 20 - Packed Tower
- Lecture 21 - Introduction to Absorption and Solvent selection
- Lecture 22 - Packed Tower Design - Part I
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- 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

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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

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

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

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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](#)

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

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

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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



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Lecture 13 - Taylor Flow : Heat transfer 1

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Lecture 15 - Taylor Flow : Meat Transfer 1

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

Lecture 19 - Flow Measurement Techniques

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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

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Lecture 12 - Summary

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Lecture 6 - Pneumatic Conveying

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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

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Lecture 18 - Measurement Techniques: Phase Fraction Measurement

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Lecture 20 - Packed Bed Reactor

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Lecture 22 - Summary

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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

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Lecture 16 - Amorphous State of Polymers

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Lecture 18 - Mechanical Properties of Polymers

Lecture 19 - Viscoelasticity: Mechanical Models

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Lecture 22 - Unentangled Polymer Dynamics

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- Lecture 1 - Introduction to Natural Gas - I
- Lecture 2 - Introduction to Natural Gas - II
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- Lecture 4 - Wellbore Performance Relationship (WPR)
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- Lecture 7 - Inflow Performance Relationship (IPR) - I
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- 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
- Lecture 20 - Transportation of Natural Gas - II
- Lecture 21 - Unconventional production of Natural Gas
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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

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Lecture 10 - Maxwell's Relations

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Lecture 12 - Thermodynamic Tables, Residual Properties

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Lecture 16 - Cubic Equation of State

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

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

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

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- [Lecture 52 - Flow meters](#)
- [Lecture 53 - Pumps](#)
- [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](#)

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

Lecture 9 - Illustrative Calculations - II

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

Lecture 28 - Illustrative Examples - III

Lecture 29 - Simultaneous Relations

Lecture 30 - Thermodynamic Consistency / Reverse Osmosis

Lecture 31 - Miscellaneous topics in phase equilibria

[Lecture 32 - Absorption Refrigeration](#)

[Lecture 33 - Summary of Classical Thermodynamics](#)

[Lecture 34 - Molecular basis of Thermodynamics - I](#)

[Lecture 35 - Molecular basis of Thermodynamics - II](#)

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.

Lecture 1 - Introduction

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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[Lecture 39 - Partial Differential Equations - Part 3](#)

[Lecture 40 - Partial Differential Equations - Part 4](#)

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](#)

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

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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

Lecture 7 - Exploratory Data Analysis - Part A

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

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

[Lecture 43 - Regression Analysis: Example Set 8 \(Continued...\)](#)

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

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

[Lecture 47 - Experimental Design Strategies - A](#)

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[Lecture 50 - Response Surface Methodology - A](#)

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[Lecture 52 - Optimal Designs - Part A](#)

[Lecture 53 - Optimal Designs - Part B](#)

[Lecture 54 - Statistics for Experimentalists - Summary Part A](#)

[Lecture 55 - Statistics for Experimentalists - Summary Part B](#)

Lecture 1 - Introduction and overview of the course: Multiphase flows

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  $R_w \ll 1$

Lecture 17 - Pulsatile flow: Perturbation solution for  $R_w \ll 1$

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



[Lecture 32 - Capillary jet instability: Linear stability analysis](#)

[Lecture 33 - Capillary jet instability: Rayleigh's Work Principle](#)

[Lecture 34 - Tutorial Session: Solution of Assignment 4 on linear stability](#)

[Lecture 35 - Turing patterns: Instability in reaction-diffusion systems](#)

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

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[Lecture 43 - Viscous Fingering: Darcy's law](#)

[Lecture 44 - Viscous Fingering: Stability analysis](#)

[Lecture 45 - Shallow Cavity flows](#)

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Lecture 2 - Introduction - Lecture 1.1 B

Lecture 3 - Introduction - Lecture 1.2 A

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Lecture 5 - Basic Definitions and concepts - Lecture 2.1 (Basic Definitions and concepts - Part I)

Lecture 6 - Basic Definitions and concepts - Lecture 2.2 (Basic Definitions and concepts - Part II)

Lecture 7 - Basic Definitions and concepts - Lecture 2.3 (Basic Definitions and concepts - Part III)

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Lecture 9 - A review of Fourier transforms - Lecture 3.2 (Continuous time Fourier transform)

Lecture 10 - A review of Fourier transforms - Lecture 3.3 (Discrete time Fourier series)

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

Lecture 12 - A review of Fourier transforms - Lecture 3.5 (Properties of Fourier transforms)

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

Lecture 15 - Duration and Bandwidth - Duration and Bandwidth

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

Lecture 28 - Properties of WVD 2

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
- Lecture 42 - Scaling Function
- Lecture 43 - Wavelets
- Lecture 44 - Wavelets
- Lecture 45 - Applications of CWT
- Lecture 46 - Applications of CWT
- Lecture 47 - Discrete Wavelet Transform
- Lecture 48 - Discrete Wavelet Transform.
- Lecture 49 - Orthogonal scaling function bases and MRA
- Lecture 50 - Orthogonal scaling function bases and MRA.
- Lecture 51 - Wavelet Filters and Fast DWT Algorithm
- 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
- Lecture 58 - DWT computation (Continued...)
- Lecture 59 - DWT computation (Continued...)

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Lecture 2 - CVD Reactor and Process Design Fundamentals

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)

Lecture 29 - Basics of Nano-Structured Material Synthesis: Part-I

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

Lecture 31 - Undesirable CVD: Bulb-Blackening (Adobe Presenter)

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

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

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

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- Lecture 2 - Motivation and Introduction - Part II
- Lecture 3 - What is Chemical Engineering - Part I
- Lecture 4 - What is Chemical Engineering - Part II
- Lecture 5 - What is Chemical Reaction Engineering - Part I
- Lecture 6 - What is Chemical Reaction Engineering - Part II
- Lecture 7 - Homogeneous and Heterogeneous Reactions - Part I
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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
- Lecture 12 - Basics of Plug Flow Reactor - Part I
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- Lecture 14 - Design of Plug Flow Reactors - Part I
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- Lecture 16 - Basics of Mixed Flow Reactors
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- Lecture 18 - Basics of Kinetics
- Lecture 19 - Kinetics of Heterogeneous reactions - Part I
- Lecture 20 - Kinetics of Heterogeneous reactions - Part II
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- Lecture 22 - Kinetics of Homogeneous reactions
- Lecture 23 - Reaction rate for Homogeneous reactions
- Lecture 24 - Gas Phase Homogeneous reactions
- Lecture 25 - (Continued...) And later Reactor Design of PFR
- Lecture 26 - Reactor Design for MFR and Combination of reactors
- Lecture 27 - PFR and MFR in series.
- Lecture 28 - Unsteady state MFR and PFR
- Lecture 29 - Recycle Reactors
- Lecture 30 - Recycle Reactors (Autocatalytic reactions) - Part I
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[Lecture 44 - Non-isothermal Plug Flow Reactors - Part I](#)

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- 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)
- Lecture 5 - Shrinking Core Model (Continued...)
- 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...)
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- 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
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- Lecture 16 - General Performance equation for non-catalytic gas solid reactions
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**NPTEL : System Identification (Chemical Engineering)**

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

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[Lecture 101 - Estimation of non-parametric model 3](#)

[Lecture 102 - Estimation of non-parametric model 4](#)

[Lecture 103 - Estimation of non-parametric model 5](#)

[Lecture 104 - Estimation of non-parametric model 3](#)

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[Lecture 106 - Estimation of non-parametric model 5](#)

[Lecture 107 - Estimation of parametric model 1](#)

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[Lecture 111 - State-Space/Subspace identification 1](#)

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[Lecture 118 - State-Space/Subspace identification 8](#)

[Lecture 119 - Input for Identification](#)

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Lecture 1 - Introduction

Lecture 2 - Fluid Statics

Lecture 3 - Newton Law of Viscosity

Lecture 4 - Equation of Continuity Differential

Lecture 5 - Equation of Linear Momentum - 1

Lecture 6 - Equation of Linear Momentum - 2

Lecture 7 - Bernoulli's Equation

Lecture 8 - Solution of Navier Stokes - 1

Lecture 9 - Solution of Navier Stokes - 1

Lecture 10 - Introduction to cylindrical coordinate systems

Lecture 11 - Continuity equation in cylindrical coordinates

Lecture 12 - Solution of Navier Stokes in the Cylindrical co-ordinate system - 1

Lecture 13 - Solution of Navier Stokes in the Cylindrical co-ordinate system - 2

Lecture 14 - Circular poiseuille flow

Lecture 15 - Shear Stress Distribution

Lecture 16 - Flow between two concentric cylinder

Lecture 17 - Taylor couette flow

Lecture 18 - Viscosity and Momentum Transfer

Lecture 19 - Device For Measuring Fluid Viscosity

Lecture 20 - Fluid Properties And its Behaviour

Lecture 21 - Tutorial 4

Lecture 22 - Choice of Scaling Parameter

Lecture 23 - Non Dimensional analysis

Lecture 24 - Non-dimensional analysis - 2

Lecture 25 - Non-dimensional analysis - 3 (Buckingham Pi Theorem)

Lecture 26 - Non-dimensional analysis - 4 (Trinity test)

Lecture 27 - Non-dimensional analysis - 5 (Concept of similarity)

Lecture 28 - Characterization Of Particles - 1

Lecture 29 - Characterization Of Particles - 2

Lecture 30 - Motion of a Particle in a fluid

Lecture 31 - Brownian motion and electrophoresis

- Lecture 32 - Sedimentation and Separation
- Lecture 33 - Settling velocity - Stoke's regime and Newton's regime
- Lecture 34 - Applications of settling - I
- Lecture 35 - Applications of settling - II
- Lecture 36 - Colloidal aggregates - Introduction
- Lecture 37 - Settling of colloidal aggregates
- Lecture 38 - Tutorial 5
- Lecture 39 - Settling of colloidal aggregates - free settling
- Lecture 40 - Settling in Multiple Particles System
- Lecture 41 - Flow Through Packed Bed
- Lecture 42 - Pressure Drop Through Packed Bed
- Lecture 43 - Tutorial 6
- Lecture 44 - Pressure Drop Through Packed bed Continue
- Lecture 45 - Fluidized Bed - 1
- Lecture 46 - Fluidized Bed - 2
- Lecture 47 - Filtration - 1
- Lecture 48 - Filtration - 2
- Lecture 49 - Tutorial 7
- Lecture 50 - Laminar and Turbulent Flows - 1
- Lecture 51 - Laminar and Turbulent Flows - 2
- Lecture 52 - Laminar and Turbulent Flows - 3
- Lecture 53 - Turbulent Stress and Turbulent Shear Layer
- Lecture 54 - Turbulent Flow near a wall and in a pipe
- Lecture 55 - Effect of rough Walls
- Lecture 56 - Roughness in Turbulent Pipe Flow
- Lecture 57 - Pipes of non-circular cross section
- Lecture 58 - Minor Losses, Sudden Expansion and Contraction
- Lecture 59 - Friction Losses in Sudden Expansion
- Lecture 60 - Tutorial 8
- Lecture 61 - Momentum and Kinetic Energy Correction Factor
- Lecture 62 - pressure drop in pipes which connected in series
- Lecture 63 - Pressure Drop in Pipes Which Connected in Parallel
- Lecture 64 - Pressure Drop in Pipes Which Connected at Junction

[Lecture 65 - Boundary Layer](#)

[Lecture 66 - Boundary Layer - Momentum Integral Analysis - 1](#)

[Lecture 67 - Boundary Layer - Momentum Integral Analysis - 2](#)

[Lecture 68 - Boundary Layer - Differential Approach](#)

[Lecture 69 - Laminar and Turbulent Boundary Layer](#)

[Lecture 70 - Tutorial 9](#)

- Lecture 1 - Measurement and Prediction - Part 1
- Lecture 2 - Measurement and Prediction - Part 2
- Lecture 3 - Overview of Transport Phenomena
- Lecture 4 - Scope of Course
- Lecture 5 - Continuum Hypothesis
- Lecture 6 - Lagrangian and Eulerian Descriptions - Part 1
- Lecture 7 - Lagrangian and Eulerian Descriptions - Part 2
- Lecture 8 - Substantial Derivative - Part 1
- Lecture 9 - Substantial Derivative - Part 2
- Lecture 10 - Substantial Derivative Example - 1
- Lecture 11 - Substantial Derivative Example - 2
- Lecture 12 - Visualization of Flow Patterns: Streamline, Pathline
- Lecture 13 - Visualization of Flow Patterns: Streakline
- Lecture 14 - Streamline, Pathline: Steady Flow Example
- Lecture 15 - Streamline, Pathline, Streakline: Unsteady Flow Example
- Lecture 16 - System and Control Volume
- Lecture 17 - Reynolds transport theorem : Introduction
- Lecture 18 - Reynolds transport theorem : Simplified form
- Lecture 19 - Reynolds transport theorem : General form - Part 1
- Lecture 20 - Reynolds transport theorem : General form - Part 2
- Lecture 21 - Integral and differential balances
- Lecture 22 - Integral total mass balance
- Lecture 23 - Integral total mass balance : Simplification
- Lecture 24 - Integral total mass balance : Examples
- Lecture 25 - Differential total mass balance - Part 1
- Lecture 26 - Differential total mass balance - Part 2
- Lecture 27 - Differential total mass balance : Examples - Part 1
- Lecture 28 - Differential total mass balance : Examples - Part 2
- Lecture 29 - Integral linear momentum balance - Part 1
- Lecture 30 - Integral linear momentum balance - Part 2
- Lecture 31 - Integral linear momentum balance : Examples - Part 1

- Lecture 32 - Integral linear momentum balance : Examples - Part 2
- Lecture 33 - Integral linear momentum balance : Examples - Part 3
- Lecture 34 - Differential linear momentum balance : Introduction
- Lecture 35 - Differential linear momentum balance : Transient, convection and body force terms
- Lecture 36 - Stress vector - Part 1
- Lecture 37 - Stress vector - Part 2
- Lecture 38 - Stress tensor - Part 1
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- Lecture 40 - Cauchy's formula
- Lecture 41 - Components of Stress Vector : Example
- Lecture 42 - Properties of stress tensor - Part 1
- Lecture 43 - Properties of stress tensor - Part 2
- Lecture 44 - Total stress tensor for fluids
- Lecture 45 - Comparison of solids and fluids
- Lecture 46 - Fluids at rest
- Lecture 47 - Differential linear momentum balance : Surface force terms
- Lecture 48 - Differential linear momentum balance : All terms
- Lecture 49 - Convective momentum flux tensor
- Lecture 50 - Differential linear momentum balance : Closure problem
- Lecture 51 - Normal Strain and Shear Strain - Part 1
- Lecture 52 - Normal Strain and Shear Strain - Part 2
- Lecture 53 - Displacement Field and Displacement Gradient - Part 1
- Lecture 54 - Displacement Field and Displacement Gradient - Part 2
- Lecture 55 - Strain Displacement Gradient Relation : Example
- Lecture 56 - Strain Displacement Gradient Relation : Normal and shear strain
- Lecture 57 - Strain Displacement Gradient Relation : Rotation and volumetric strain
- Lecture 58 - Strain Displacement Gradient Relation : Examples
- Lecture 59 - Displacement Gradient Tensor
- Lecture 60 - Components of Total Displacement - Part 1
- Lecture 61 - Components of Total Displacement - Part 2
- Lecture 62 - Strain Tensor and Rotation Tensor - Part 1
- Lecture 63 - Components of Total Displacement : Example
- Lecture 64 - Normal and Shear Strain Rate

- Lecture 65 - Strain Rate Velocity Gradient Relation
- Lecture 66 - Volumetric Strain Rate
- Lecture 67 - Velocity Gradient Tensor
- Lecture 68 - Strain Rate : Example 1
- Lecture 69 - Strain Rate : Example 2
- Lecture 70 - Stress Strain Relation : Introduction
- Lecture 71 - Material Properties
- Lecture 72 - Hooke's Law - Strain-stress Relation
- Lecture 73 - Relation Between Material Properties
- Lecture 74 - Hooke's Law - Stress-strain Relation
- Lecture 75 - Hooke's Law : Examples
- Lecture 76 - Stress Strain Rate Relation : Introduction
- Lecture 77 - Newton's Law of Viscosity : 1D Form
- Lecture 78 - Newton's Law of Viscosity : 3D Form
- Lecture 79 - Navier Stokes Equation
- Lecture 80 - Fluid at Rest : Pressure Distribution
- Lecture 81 - Hydrostatic Pressure Distribution in Liquid
- Lecture 82 - Hydrostatic Pressure Distribution in Gas
- Lecture 83 - Fluid in Rigid Body Motion : Pressure Distribution
- Lecture 84 - Flow Regimes : Laminar and Turbulent flow
- Lecture 85 - Euler Equation
- Lecture 86 - Bernoulli Equation : Inviscid Flow
- Lecture 87 - Bernoulli Equation : Example 1
- Lecture 88 - Bernoulli Equation : Irrotational Flow
- Lecture 89 - Bernoulli Equation : Example 2
- Lecture 90 - Planar Couette Flow - Governing Equations
- Lecture 91 - Planar Couette Flow - Velocity and Pressure Distribution
- Lecture 92 - Planar Couette Flow - Shear Force
- Lecture 93 - Planar Poiseuille Flow : Governing Equations
- Lecture 94 - Planar Poiseuille Flow : Velocity and Pressure Distribution
- Lecture 95 - Planar Poiseuille Flow : Shear force
- Lecture 96 - Planar Poiseuille Flow : Shear Stress Distribution
- Lecture 97 - Viscous Stress vs. Molecular Momentum Flux - Part 1



- [Lecture 98 - Viscous Stress vs. Molecular Momentum Flux - Part 2](#)
- [Lecture 99 - Linear Momentum Balance : Fluid Mechanics vs. Momentum Transport - Part 1](#)
- [Lecture 100 - Linear Momentum Balance : Fluid Mechanics vs. Momentum Transport - Part 2](#)
- [Lecture 101 - Viscous Stress vs. Molecular Momentum Flux - Part 3](#)
- [Lecture 102 - Integral Energy Balance - Part 1](#)
- [Lecture 103 - Integral Energy Balance - Part 2](#)
- [Lecture 104 - Simplification of Integral Energy Balance](#)
- [Lecture 105 - Integral Energy Balance : Examples](#)
- [Lecture 106 - Differential Energy Balance : Introduction](#)
- [Lecture 107 - Differential Total Energy Balance - Part 1](#)
- [Lecture 108 - Differential Total Energy Balance - Part 2](#)
- [Lecture 109 - Differential Energy Balance - Part 1](#)
- [Lecture 110 - Differential Energy Balance - Part 2](#)
- [Lecture 111 - Differential Energy Balance - Part 3](#)
- [Lecture 112 - Fourier's Law of Heat Conduction](#)
- [Lecture 113 - Simplifications of Differential Energy Balance](#)
- [Lecture 114 - Heat Conduction in Slab](#)
- [Lecture 115 - Heat Conduction in Furnace Wall](#)
- [Lecture 116 - Non Isothermal Planar Couette Flow](#)

Lecture 1 - Introduction

Lecture 2 - Chemicals of Concern

Lecture 3 - Water Quality Screening Parameters

Lecture 4 - Water Quality Parameters

Lecture 5 - Air quality parameters; Sustainability

Lecture 6 - PM - Particulate Matter

Lecture 7 - Physical/Chemical properties of interest

Lecture 8 - Partition Constants

Lecture 9 - Soil-air partition constants

Lecture 10 - Application/Example of Equilibrium Partitioning

Lecture 11 - Introduction to Environmental Monitoring and Sampling

Lecture 12 - Environmental Sampling

Lecture 13 - Environmental Analysis: Quality Control - Part 1

Lecture 14 - Environmental Analysis: Quality Control - Part 2

Lecture 15 - Environmental Analysis of Organics in Water

Lecture 16 - Environmental Analysis: Quality Control - Part 3

Lecture 17 - Tutorial

Lecture 18 - Tutorial (Continued...)

Lecture 19 - Analysis Methods - Introduction and Water Quality Parameters

Lecture 20 - Analysis Methods - Water Quality Parameters

Lecture 21 - Analysis Methods - Review of Standard Methods

Lecture 22 - Analysis Methods - Organics in water

Lecture 23 - Analysis Methods - Overall Methodology for Organics

Lecture 24 - Analysis Methods - Chromatography Fundamentals

Lecture 25 - Analysis Methods - Gas Chromatography

Lecture 26 - Analysis Methods - Gas Chromatography (Mass Spectrometry)

Lecture 27 - Analysis Methods - Liquid Chromatography

Lecture 28 - Monitoring methods for Air - PM - Part 1

Lecture 29 - Monitoring methods for Air - PM - Part 2

Lecture 30 - Monitoring methods for Air - Vapor - Part 1

Lecture 31 - Monitoring methods for Air - Vapor - Part 2

- [Lecture 32 - Monitoring methods for Air - Vapor - Part 3](#)
- [Lecture 33 - Monitoring and Measurement of Microorganisms](#)
- [Lecture 34 - Transport of Pollutants - Introduction](#)
- [Lecture 35 - Transport of Pollutants - Box Models in Water](#)
- [Lecture 36 - Transport of Pollutants - Box Models in Air](#)
- [Lecture 37 - Transport of Pollutants - Dispersion](#)
- [Lecture 38 - Transport of Pollutants - Gaussian Dispersion Model](#)
- [Lecture 39 - Dispersion Model - Parameters - Part 1](#)
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- [Lecture 41 - Gaussian Dispersion Model](#)
- [Lecture 42 - Gaussian Dispersion Model - Example, Additional topics](#)
- [Lecture 43 - Regulatory Models](#)
- [Lecture 44 - Introduction to Interphase Mass Transfer](#)
- [Lecture 45 - Interphase mass transfer - Application to Environmental Interfaces](#)
- [Lecture 46 - Interphase mass transfer - Flux and mass transfer resistance](#)
- [Lecture 47 - Interphase mass transfer - Boundary Layer and Mass Transfer Coefficient](#)
- [Lecture 48 - Interphase mass transfer - Individual and Overall Mass Transfer Coefficients](#)
- [Lecture 49 - Overall Mass Transfer Coefficient](#)
- [Lecture 50 - Estimation of the Mass Transfer Coefficients](#)
- [Lecture 51 - Air-Water Exchange](#)
- [Lecture 52 - Evaporation from different surfaces](#)
- [Lecture 53 - Sediment-Water exchange](#)
- [Lecture 54 - Application of Interphase mass transfer](#)
- [Lecture 55 - Contamination of Sediments](#)
- [Lecture 56 - Release from Sediments](#)
- [Lecture 57 - Unsteady state release from sediments](#)
- [Lecture 58 - Other mechanisms of chemical release from sediments - Part 1](#)
- [Lecture 59 - Other mechanisms of chemical release from sediments - Part 2](#)
- [Lecture 60 - Soil - Air Transfer](#)
- [Lecture 61 - Remediation of contaminated sediments - Application of transport models](#)

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

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

Lecture 1 - Impetus

Lecture 2 - Introduction to Supramolecular Science and Technology

Lecture 3 - Introduction to Supramolecular Science and Technology

Lecture 4 - A quickwalk - through the Supramolecular Architectures

Lecture 5 - A quickwalk - through the Supramolecular Architectures

Lecture 6 - A quickwalk - through the Supramolecular Architectures

Lecture 7 - Weak intermolecular forces : What, Where, When and How?

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

[Lecture 31](#)

[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 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 : Status 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 Petrochemicals

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 Autonomous Learning 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

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](#)

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- Lecture 2 - Classification of polymers, Types of polymerization, Average molecular weights and polydispersity
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- Lecture 5 - Random Walk Models of Single Chain II: general random walk on a lattice
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- Lecture 7 - Models of semiflexible chains (Kratky Porod Model) - Part I
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- Lecture 11 - Entropic Elasticity, Bead-Spring Model, Simulations of random walk models
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- Lecture 13 - Definition of Radius of gyration
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- Lecture 15 - Nonbonded interactions, hydrophobic and hydrophilic behaviour
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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

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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

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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

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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

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

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