

Lecture 1 - Introduction

Lecture 2 - Flow Classifications

Lecture 3 - Laws of Convection

Lecture 4 - Scalar Transport Equations

Lecture 5 - Laminar Boundary Layers

Lecture 6 - Similarity Method

Lecture 7 - Similarity Solns Velocity BL

Lecture 8 - Similarity Solns Temperature BL - I

Lecture 9 - Similarity Solns Temperature BL - II

Lecture 10 - Integral BL Equations

Lecture 11 - Integral Solns Laminar Velocity BL

Lecture 12 - Integral Solns Laminar Temperature BL

Lecture 13 - Superposition Theory

Lecture 14 - Laminar Internal Flows

Lecture 15 - Fully-Developed Laminar Flows - 1

Lecture 16 - Fully-Developed Laminar Flows - 2

Lecture 17 - Fully-Developed Laminar Flows Heat Transfer - 1

Lecture 18 - Fully-Developed Laminar Flows Heat Transfer - 2

Lecture 19 - Laminar Internal Developing Flows Heat Transfer

Lecture 20 - Superposition Technique

Lecture 21 - Nature of Turbulent Flows

Lecture 22 - Sustaining Mechanism of Turbulence - 1

Lecture 23 - Sustaining Mechanism of Turbulence - 1

Lecture 24 - Sustaining Mechanism of Turbulence - 2

Lecture 25 - Near-Wall Turbulent Flows - 1

Lecture 26 - Near-Wall Turbulent Flows - 2

Lecture 27 - Turbulence Models - 1

Lecture 28 - Turbulence Models - 2

Lecture 29 - Turbulence Models - 3

Lecture 30 - Prediction of Turbulent Flows

Lecture 31 - Prediction of Turbulent Heat Transfer

[Lecture 32 - Convective Mass Transfer](#)

[Lecture 33 - Stefan Flow Model](#)

[Lecture 34 - Couette Flow Model](#)

[Lecture 35 - Reynolds Flow Model](#)

[Lecture 36 - Boundary Layer Flow Model](#)

[Lecture 37 - Evaluation of  \$g\$  and  \$Nw\$](#)

[Lecture 38 - Diffusion Mass Transfer Problems](#)

[Lecture 39 - Convective MT Couette Flow](#)

[Lecture 40 - Convective MT Reynolds Flow Model - 1](#)

[Lecture 41 - Convective MT Reynolds Flow Model - 2](#)

[Lecture 42 - Natural Convection](#)

[Lecture 43 - Diffusion Jet Flames](#)

**NPTEL : Cryogenic Engineering (Mechanical Engineering)**

**Co-ordinators : Prof. M.D. Atrey**

- Lecture 1 - Introduction to Cryogenic Engineering
- Lecture 2 - Properties of Cryogenic Fluids - I
- Lecture 3 - Properties of Cryogenic Fluids - II
- Lecture 4 - Properties of Cryogenic
- Lecture 5 - Material Properties at Low Temperature - I
- Lecture 6 - Material Properties at Low Temperature - II
- Lecture 7 - Material Properties at Low Temperature - III
- Lecture 8 - Gas Liquefaction and Refrigeration Systems - I
- Lecture 9 - Gas Liquefaction and Refrigeration Systems - II
- Lecture 10 - Gas Liquefaction and Refrigeration Systems - III
- Lecture 11 - Gas Liquefaction and Refrigeration Systems - IV
- Lecture 12 - Gas Liquefaction and Refrigeration Systems - V
- Lecture 13 - Gas Liquefaction and Refrigeration Systems - VI
- Lecture 14 - Gas Liquefaction and Refrigeration Systems - VII
- Lecture 15 - Gas Liquefaction and Refrigeration Systems - VIII
- Lecture 16 - Gas Liquefaction and Refrigeration Systems - IX
- Lecture 17 - Gas Liquefaction and Refrigeration Systems - X
- Lecture 18 - Gas Separation - I
- Lecture 19 - Gas Separation - II
- Lecture 20 - Gas Separation - III
- Lecture 21 - Gas Separation - IV
- Lecture 22 - Gas Separation - V
- Lecture 23 - Gas Separation - VI
- Lecture 24 - Gas Separation - VII
- Lecture 25 - Gas Separation - VIII
- Lecture 26 - Cryocoolers
- Lecture 27 - Cryocoolers Ideal Stirling Cycle - I
- Lecture 28 - Cryocoolers Ideal Stirling Cycle - II
- Lecture 29 - Cryocoolers Ideal Stirling Cycle - III
- Lecture 30 - Cryocoolers Ideal Stirling Cycle - IV
- Lecture 31 - Cryocoolers Ideal Stirling Cycle - V

[Lecture 32 - Cryocoolers](#)

[Lecture 33 - Cryogenic Insulation - I](#)

[Lecture 34 - Cryogenic Insulation - II](#)

[Lecture 35 - Cryogenic Insulation - III](#)

[Lecture 36 - Vacuum Technology - I](#)

[Lecture 37 - Vacuum Technology - II](#)

[Lecture 38 - Vacuum Technology - III](#)

[Lecture 39 - Instrumentation in Cryogenics - I](#)

[Lecture 40 - Instrumentation in Cryogenics - II](#)

[Lecture 41 - Instrumentation in Cryogenics - III](#)

[Lecture 42 - Safety in Cryogenics](#)



Lecture 1 - Stress and Strain Tensor

Lecture 2 - Stress and Strain Tensor (Continued) and Cauchy Formula for Traction

Lecture 3 - Examples on Calculation of Strains and Traction, Principal Stresses and Directions

Lecture 4 - Example on Calculation of Principal Stresses and Directions, Orthogonality of Principal Directions, Principal Stresses are all Real

Lecture 5 - Maximum Shear Stress and Octahedral Shear Stress, Deviatoric and Hydrostatic Stresses

Lecture 6 - Transformation of Stresses and Mohr Circle in 3-D

Lecture 7 - Mohr Circle (Continued)

Lecture 8 - Deformation, Rotation and Strain Tensors, Principal Strains, Deviatoric and Hydrostatic Strains

Lecture 9 - Strain Transformations, Strains in Polar Coordinates, Equilibrium Equations in 2-D

Lecture 10 - Equilibrium Equations in 2-D Polar Coordinates Plane Stress and Plane Strain Conditions

Lecture 11 - Stress-Strain Relations for Isotropic, Orthotropic and Anisotropic Materials Stress-Strain-Temperature Relations

Lecture 12 - Relation between Elastic Constants and Strain Energy Densities Recap of Lectures 1 to 11

Lecture 13 - Stress Distribution in Thick Cylinder

Lecture 14 - Stresses due to Shrink Fitting

Lecture 15 - Stresses in Rotating Disc

Lecture 16 - Examples on Shrink Fitting and Rotating Disc

Lecture 17 - Torsion of Non-Circular Shaft

Lecture 18 - Torsion of Non-Circular Shaft (Continued)

Lecture 19 - Membrane Analogy for Torsion

Lecture 20 - Torsion of Thin Box Sections

Lecture 21 - Torsion of Box and Open Sections

Lecture 22 - Bending of Curved Bars

Lecture 23 - Bending of Curved Bars (Continued)

Lecture 24 - Theories of Failure

Lecture 25 - Theories of Failure (Continued)

Lecture 26 - Theories of Failure (Continued) and Their Applications, Griffith Theory of Brittle Fracture

Lecture 27 - Application of Griffith Theory, Irwin-Orowan Modification of Griffith Theory, Assessment of Effect of Dynamic Loading

Lecture 28 - Theorems of Elasticity

Lecture 29 - Theorems of Elasticity (Continued)

Lecture 30 - Thermal Stress Distribution in Rectangular Sheet due to Symmetric and Asymmetric Temperature Fields

[Lecture 31 - Thermal Stress Distribution in Cylinders](#)

[Lecture 32 - Unsymmetrical Bending](#)

[Lecture 33 - Shear Centre](#)

[Lecture 34 - Plate Bending](#)

[Lecture 35 - Plate Bending \(Continued\)](#)

[Lecture 36 - Examples on Plate Bending](#)

[Lecture 37 - Approximate Solutions for Bending of Rectangular and Circular Plates](#)

[Lecture 38 - Thin Shells of Revolution](#)

[Lecture 39 - Beam on Elastic Foundation](#)

[Lecture 40 - Application of Beam on Elastic Foundation Analysis to Pressure Vessels for Calculation of Discontinuity Stresses](#)

Lecture 1 - Introduction to Heat and Mass Transfer

Lecture 2 - Introduction

Lecture 3 - Introduction

Lecture 4 - Heat Conduction - 1

Lecture 5 - Heat Conduction - 2

Lecture 6 - Heat Conduction - 3

Lecture 7 - Heat Conduction - 4

Lecture 8 - Heat Conduction - 5

Lecture 9 - Heat Conduction - 6

Lecture 10 - Thermal Radiation - 1

Lecture 11 - Thermal Radiation - 2

Lecture 12 - Thermal Radiation - 3

Lecture 13 - Thermal Radiation - 4

Lecture 14 - Thermal Radiation - 5

Lecture 15 - Thermal Radiation - 6

Lecture 16 - Review Of Fluid Mechanics - 1

Lecture 17 - Review Of Fluid Mechanics - 2

Lecture 18 - Forced Convection - 1

Lecture 19 - Forced Convection - 2

Lecture 20 - Forced Convection - 3

Lecture 21 - Forced Convection - 4

Lecture 22 - Natural Convection - 1

Lecture 23 - Natural Convection - 2

Lecture 24 - Natural Convection - 3

Lecture 25 - Heat Exchangers - 1

Lecture 26 - Heat Exchangers - 2

Lecture 27 - Heat Exchangers - 3

Lecture 28 - Heat Exchangers - 4

Lecture 29 - Boiling and Condensation - 1

Lecture 30 - Boiling and Condensation - 2

Lecture 31 - Boiling and Condensation - 3

[Lecture 32 - Boiling and Condensation - 4](#)

[Lecture 33 - Introduction to Mass Transfer - 1](#)

[Lecture 34 - Introduction to Mass Transfer - 2](#)

[Lecture 35 - Introduction to Mass Transfer - 3](#)

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

## NPTEL : Robotics (Mechanical Engineering)

**Co-ordinators : Prof. P. Seshu, Prof. P.S. Gandhi, Prof. K. Kurien Issac, Prof. B. Seth, Prof. C. Amarnath**

Lecture 1 - Introduction to Robotics

Lecture 2 - Technologies in Robots

Lecture 3 - Industrial Robots

Lecture 4 - Industrial Manipulators and its Kinematics

Lecture 5 - Parallel Manipulators

Lecture 6 - Grippers manipulators

Lecture 7 - Electric Actuators

Lecture 8 - Actuators - Electric, Hydraulic, Pneumatic

Lecture 9 - Internal State Sensors

Lecture 10 - Internal State Sensors

Lecture 11 - External State Sensors

Lecture 12 - Trajectory planning

Lecture 13 - Trajectory planning

Lecture 14 - Trajectory planning

Lecture 15 - Trajectory planning

Lecture 16 - Trajectory planning

Lecture 17 - Trajectory planning

Lecture 18 - Trajectory planning

Lecture 19 - Trajectory planning

Lecture 20 - Forward Position Control

Lecture 21 - Inverse Problem

Lecture 22 - Velocity Analysis

Lecture 23 - Velocity Analysis

Lecture 24 - Dynamic Analysis

Lecture 25 - Image Processing

Lecture 26 - Image Processing

Lecture 27 - Image Processing

Lecture 28 - Image Processing

Lecture 29 - Image Processing

Lecture 30 - Image Processing

Lecture 31 - Robot Dynamics and Control

[Lecture 32 - Robot Dynamics and Control](#)

[Lecture 33 - Robot Dynamics and Control](#)

[Lecture 34 - Robot Dynamics and Control](#)

[Lecture 35 - Robot Dynamics and Control](#)

[Lecture 36 - Robot Dynamics and Control](#)

[Lecture 37 - Futuristic Topics in Robotics](#)

[Lecture 38 - Robot Dynamic and Control-Case Studies](#)

[Lecture 39 - Robot Dynamic and Control-Case Studies](#)

[Lecture 40 - Futuristic Topics in Robotics](#)

Lecture 1 - Introduction

Lecture 2 - Isoperimetric problem

Lecture 3 - Review of real analysis (sequences and convergence)

Lecture 4 - Bolzano-Weierstrass theorem and completeness axiom

Lecture 5 - Open sets, closed sets and compact sets

Lecture 6 - Continuity and Weierstrass theorem

Lecture 7 - Weierstrass theorem

Lecture 8 - Different solution concepts

Lecture 9 - Different types of constraints

Lecture 10 - Taylor's theorem

Lecture 11 - First order sufficient condition

Lecture 12 - Second order necessary condition

Lecture 13 - Least square regression

Lecture 14 - Least square regression (Continued...)

Lecture 15 - Implicit function theorem

Lecture 16 - Optimization with equality constraints and introduction to Lagrange multipliers - I

Lecture 17 - Optimization with equality constraints and introduction to Lagrange multipliers - II

Lecture 18 - Least norm solution of underdetermined linear system

Lecture 19 - Transformation of optimization problems - I

Lecture 20 - Transformation of optimization problems - II

Lecture 21 - Transformation of optimization problems - III

Lecture 22 - Convex Analysis - I

Lecture 23 - Convex Analysis - II

Lecture 24 - Convex Analysis - III

Lecture 25 - Polyhedrons

Lecture 26 - Minkowski-Weyl Theorem

Lecture 27 - Linear Programming Problems

Lecture 28 - Extreme points and optimal solution of an LP

Lecture 29 - Extreme points and optimal solution of an LP (Continued...)

Lecture 30 - Extreme points and basic feasible solutions

Lecture 31 - Equivalence of extreme point and BFS

[Lecture 32 - Equivalence of extreme point and BFS \(Continued...\)](#)

[Lecture 33 - Examples of Linear Programming](#)

[Lecture 34 - Weak and Strong duality](#)

[Lecture 35 - Proof of strong duality](#)

[Lecture 36 - Proof of strong duality \(Continued...\)](#)

[Lecture 37 - Farkas' lemma](#)

[Lecture 38 - Max-flow Min-cut problem](#)

[Lecture 39 - Shortest path problem](#)

[Lecture 40 - Complementary Slackness](#)

[Lecture 41 - Proof of complementary slackness](#)

[Lecture 42 - Tangent cones](#)

[Lecture 43 - Tangent cones \(Continued...\)](#)

[Lecture 44 - Constraint qualifications, Farkas' lemma and KKT](#)

[Lecture 45 - KKT conditions](#)

[Lecture 46 - Convex optimization and KKT conditions](#)

[Lecture 47 - Slater condition and Lagrangian Dual](#)

[Lecture 48 - Weak duality in convex optimization and Fenchel dual](#)

[Lecture 49 - Geometry of the Lagrangian](#)

[Lecture 50 - Strong duality in convex optimization - I](#)

[Lecture 51 - Strong duality in convex optimization - II](#)

[Lecture 52 - Strong duality in convex optimization - III](#)

[Lecture 53 - Line search methods for unconstrained optimization](#)

[Lecture 54 - Wolfe conditions](#)

[Lecture 55 - Line search algorithm and convergence](#)

[Lecture 56 - Steepest descent method and rate of convergence](#)

[Lecture 57 - Newton's method](#)

[Lecture 58 - Penalty methods](#)

[Lecture 59 - L1 and L2 Penalty methods](#)

[Lecture 60 - Augmented Lagrangian methods](#)

[Lecture 61 - Cutting plane methods](#)

[Lecture 62 - Interior point methods for linear programming](#)

[Lecture 63 - Dynamic programming: Inventory control problem](#)

[Lecture 64 - Policy and value function](#)



[Lecture 65 - Principle of optimality in dynamic programming](#)

[Lecture 66 - Principle of optimality applied to inventory control problem](#)

[Lecture 67 - Optimal control for a system with linear state dynamics and quadratic cost](#)

Lecture 1 - Introduction

Lecture 2 - Elements of Mechatronic Systems - Part I

Lecture 3 - Elements of Mechatronic Systems - Part II

Lecture 4 - Elements of Mechatronic Systems - Part III

Lecture 5 - CD-ROM - Part I

Lecture 6 - CD-ROM - Part II

Lecture 7 - CD-ROM - Part III

Lecture 8 - Scanner

Lecture 9 - Integrated Mechanical-Electronics Philosophy - Part I

Lecture 10 - Integrated Mechanical-Electronics Philosophy - Part II

Lecture 11 - Smart Sensors Concept

Lecture 12 - Compliant Mechanisms

Lecture 13 - Microprocessor Building Blocks I - Combinational Circuits

Lecture 14 - Microprocessor Building Blocks II - Sequential Circuits

Lecture 15 - Microprocessor Memory and Addressing

Lecture 16 - Timing and control unit: Primitive Microprocessor

Lecture 17 - Microcontroller Architecture - I

Lecture 18 - Microcontroller Architecture - II

Lecture 19 - Microcontroller Programming Philosophy

Lecture 20 - Hardware Interfaces

Lecture 21 - Interfacing Actuator using PWM in Tiva Microcontroller

Lecture 22 - Interfacing Encoder using QEI in Tiva Launchpad + ISR

Lecture 23 - Mathematical Modelling: Overview and Context

Lecture 24 - Modelling Friction in a System

Lecture 25 - Modelling DC Motor with loads

Lecture 26 - Lagrange formulation fundamentals

Lecture 27 - Lagrange formulation examples

Lecture 28 - Dynamics: 2-R Manipulator

Lecture 29 - Control formulation: Regulation and Tracking

Lecture 30 - Fundamentals of Simulation of dynamics using MATLAB

Lecture 31 - Selection of Sensors and Actuators - Part I

[Lecture 32 - Selection of Sensors and Actuators - Part II](#)

[Lecture 33 - Concept of feedback](#)

[Lecture 34 - Closed loop control implementation in microcontroller](#)

[Lecture 35 - Mathematical representations of systems for control](#)

[Lecture 36 - Control design for linear systems](#)

[Lecture 37 - Application of control design for linear systems](#)

[Lecture 38 - Mathematical Preliminaries- Nonlinear Control](#)

[Lecture 39 - Fundamentals of Lyapunov theory](#)

[Lecture 40 - Application of Lyapunov stability analysis](#)

[Lecture 41 - Trajectory tracking controller: Robotic system](#)

[Lecture 42 - Fundamentals of sampling](#)

[Lecture 43 - Shannon sampling theorem and signal reconstruction](#)

[Lecture 44 - Signal processing](#)

[Lecture 45 - Digital system representation and filters for mechatronics](#)

[Lecture 46 - Case study: Development of 3D microprinting system](#)

[Lecture 47 - Case study: 3D microprinting via Bulk lithography](#)

[Lecture 48 - Case study: Hele-Shaw system for novel fabrication](#)

Lecture 1 - Basic Concepts and Nomenclature

Lecture 2 - Preliminaries - Part 1

Lecture 3 - Preliminaries - Part 2

Lecture 4 - Preliminaries - Part 3

Lecture 5 - Preliminaries - Part 4

Lecture 6 - Preliminaries - Part 5

Lecture 7 - Barbalat's Lemma - Part 1

Lecture 8 - Barbalat's Lemma - Part 2

Lecture 9 - Convergence of Signals using Barbalat's Lemma - Part 1

Lecture 10 - Convergence of Signals using Barbalat's Lemma - Part 2

Lecture 11 - Notions of Stability - Part 1

Lecture 12 - Notions of Stability - Part 2

Lecture 13 - Stability Analysis with Examples - Part 1

Lecture 14 - Stability Analysis with Examples - Part 2

Lecture 15 - Stability Analysis with Examples - Part 3

Lecture 16 - Stability Analysis with Examples - Part 4

Lecture 17 - Stability Analysis in Linear Systems

Lecture 18 - Function Classes and Definiteness

Lecture 19 - Positive Definite Functions

Lecture 20 - Radially Unbounded Functions

Lecture 21 - Decrescent Functions

Lecture 22 - Lyapunov Stability Theorems - Part 1

Lecture 23 - Lyapunov Stability Theorems - Part 2

Lecture 24 - Lyapunov Stability Theorems - Part 3

Lecture 25 - Exponential Stability and Converse Lyapunov Theorems

Lecture 26 - Persistence of Excitation (PE): Introduction

Lecture 27 - Connection of PE to Stability, Uniform Complete Observability (UCO)

Lecture 28 - Exponential Stability of LTV systems, PE and Exponential Stability

Lecture 29 - Parameter Identifier Convergence under PE Condition

Lecture 30 - Analysis of Parameter Varying Systems using General Integral Lemma - Part 1

Lecture 31 - Analysis of Parameter Varying Systems using General Integral Lemma - Part 2

- Lecture 32 - Adaptive Control Design: First Order Scalar Systems
- Lecture 33 - Barbalat's Lemma and Signal Chasing Analysis
- Lecture 34 - Parameter Convergence in Adaptive Control Design
- Lecture 35 - Adaptive Control Design: Second-Order Systems
- Lecture 36 - Overcoming the Detectability Obstacle: Ortega Construction
- Lecture 37 - Backstepping in Adaptive Control: Introduction - Part 1
- Lecture 38 - Backstepping in Adaptive Control: Introduction - Part 2
- Lecture 39 - Backstepping in Adaptive Control: Parameters Unmatched with Control - Part 1
- Lecture 40 - Backstepping in Adaptive Control: Parameters Unmatched with Control - Part 2
- Lecture 41 - How to Deal with Unknown Gains in Control
- Lecture 42 - Setup of Model Reference Adaptive Control (MRAC) Problem
- Lecture 43 - Model Reference Adaptive control: For Known and Unknown Parameters
- Lecture 44 - Model Reference Adaptive control: Lyapunov Stability Analysis
- Lecture 45 - Generalization of Adaptive Integrator Backstepping Method - Part 1
- Lecture 46 - Generalization of Adaptive Integrator Backstepping Method - Part 2
- Lecture 47 - Extended Matching Design for Avoiding Overparameterization
- Lecture 48 - Adaptive Integrator Backstepping Method: An Example - Part 1
- Lecture 49 - Adaptive Integrator Backstepping Method: An Example - Part 2
- Lecture 50 - Extended Matching Design: An Example
- Lecture 51 - Control Lyapunov Function
- Lecture 52 - Tuning Function Adaptive Method
- Lecture 53 - Adaptive Backstepping via Control Lyapunov Function (CLF)
- Lecture 54 - Adaptive Backstepping via CLF: An Example
- Lecture 55 - Robustness in Adaptive Control - Part 1
- Lecture 56 - Robustness in Adaptive Control - Part 2
- Lecture 57 - Parameter Projection in Adaptive Control - Part 1
- Lecture 58 - Parameter Projection in Adaptive Control - Part 2
- Lecture 59 - Parameter Projection in Adaptive Control - Part 3
- Lecture 60 - Sigma- Modification and Epsilon-Modification in Adaptive Control
- Lecture 61 - Initial Excitation in Adaptive Control - Part 1
- Lecture 62 - Initial Excitation in Adaptive Control - Part 2
- Lecture 63 - Initial Excitation in Adaptive Control - Part 3
- Lecture 64 - Initial Excitation in Adaptive Control - Part 4

[Lecture 65 - Initial Excitation in Adaptive Control - Part 5](#)

[Lecture 66 - Discussion on Historical Developments in Adaptive Control and Learning](#)

[Lecture 67 - Real Time Neural Network Based Control of a Robotic Manipulator - Part 1](#)

[Lecture 68 - Real Time Neural Network Based Control of a Robotic Manipulator - Part 2](#)

[Lecture 69 - Real Time Neural Network Based Control of a Robotic Manipulator - Part 3](#)

[Lecture 70 - Real Time Neural Network Based Control of a Robotic Manipulator - Part 4](#)

[Lecture 71 - Real Time Neural Network Based Control of a Robotic Manipulator - Part 5](#)

Lecture 1 - Course Introduction

Lecture 2 - Examples of Nonlinear systems

Lecture 3 - Existence and uniqueness of solutions

Lecture 4 - Preliminaries and notations

Lecture 5 - Preliminaries: Normed linear space

Lecture 6 - Preliminaries: Induced Matrix Norms and Signal Norms

Lecture 7 - Signal Norms and Cauchy-Schwarz Inequality

Lecture 8 - Stability - Part 1

Lecture 9 - Stability - Part 2

Lecture 10 - Stability - Part 3

Lecture 11 - Stability - Part 4

Lecture 12 - Stability - Part 5

Lecture 13 - Lyapunov stability Theorems - Part 1

Lecture 14 - Lyapunov stability Theorems - Part 2

Lecture 15 - Lyapunov stability Theorems - Part 3

Lecture 16 - Lyapunov stability Theorems - Part 4

Lecture 17 - Lyapunov stability Theorems - Part 5

Lecture 18 - Lyapunov stability Theorems - Part 6

Lecture 19 - Proofs of Lyapunov Stability Theorems - Part 1

Lecture 20 - Proofs of Lyapunov Stability Theorems - Part 2

Lecture 21 - Proofs of Lyapunov Stability Theorems - Part 3

Lecture 22 - Proofs of Lyapunov Stability Theorems - Part 4

Lecture 23 - La Salle's Invariance Principle - Part 1

Lecture 24 - La Salle's Invariance Principle - Part 2

Lecture 25 - La Salle's Invariance Principle - Part 3

Lecture 26 - La Salle's Invariance Principle - Part 4

Lecture 27 - La Salle's Invariance Principle - Part 5

Lecture 28 - La Salle's Invariance Principle - Part 6

Lecture 29 - Control Lyapunov functions - Part 1

Lecture 30 - Control Lyapunov functions - Part 2

Lecture 31 - Control Lyapunov functions - Part 3

[Lecture 32 - Control Lyapunov functions - Part 4](#)

[Lecture 33 - Control Lyapunov functions - Part 5](#)

[Lecture 34 - Backstepping method for control design - Part 1](#)

[Lecture 35 - Backstepping method for control design - Part 2](#)

[Lecture 36 - Backstepping method for control design - Part 3](#)

[Lecture 37 - Backstepping method for control design - Part 4](#)

[Lecture 38 - Passivity based control - Part 1](#)

[Lecture 39 - Passivity based control - Part 2](#)

[Lecture 40 - Passivity based control - Part 3](#)

[Lecture 41 - Passivity in control systems - Part 1 \(Prof. Antonio Loria\)](#)

[Lecture 42 - Passivity in control systems - Part 2 \(Prof. Antonio Loria\)](#)

[Lecture 43 - Passivity in control systems - Part 3 \(Prof. Antonio Loria\)](#)

[Lecture 44 - Passivity in control systems - Part 4 \(Prof. Antonio Loria\)](#)

[Lecture 45 - Passivity based control - Part 4](#)

[Lecture 46 - Passivity based control - Part 5](#)

[Lecture 47 - Passivity based control - Part 6](#)

[Lecture 48 - Passivity based control - Part 7](#)

[Lecture 49 - Feedback Linearization - Part 1](#)

[Lecture 50 - Feedback Linearization - Part 2](#)

[Lecture 51 - Feedback Linearization - Part 3](#)

[Lecture 52 - Feedback Linearization - Part 4](#)

[Lecture 53 - Feedback Linearization - Part 5](#)

[Lecture 54 - Feedback Linearization - Part 6](#)

[Lecture 55 - Feedback Linearization - Part 6](#)

[Lecture 56 - Feedback Linearization - Part 7](#)

[Lecture 57 - Feedback Linearization - Part 8](#)

[Lecture 58 - Feedback Linearization - Part 9](#)

[Lecture 59 - Feedback Linearization - Part 10](#)

[Lecture 60 - Feedback Linearization - Part 11](#)

[Lecture 61 - Barbalat's Lemma](#)

[Lecture 62 - Application of Barbalat's Lemma](#)

[Lecture 63 - Adaptive control - Part 1](#)

[Lecture 64 - Adaptive control - Part 2](#)



[Lecture 65 - State constrained control - Part 1](#)

[Lecture 66 - State constrained control - Part 2](#)

[Lecture 67 - State constrained control - Part 3](#)

[Lecture 68 - Finite time stability - Part 1](#)

[Lecture 69 - Finite time stability - Part 2](#)

[Lecture 70 - Finite time stability - Part 3](#)

[Lecture 71 - Sliding mode control - Part 1](#)

[Lecture 72 - Sliding mode control - Part 2](#)

[Lecture 73 - Sliding mode control - Part 3](#)

Lecture 1 - Introduction

Lecture 2 - Interdisciplinary Approach and Economic Benefits

Lecture 3 - Friction

Lecture 4 - Friction Estimation

Lecture 5 - Friction Instability

Lecture 6 - Wear

Lecture 7 - Adhesive Wear

Lecture 8 - Wear Mechanisms

Lecture 9 - Wear Mechanisms - 2

Lecture 10 - Wear Analysis

Lecture 11 - Lubrication and Lubricants

Lecture 12 - Boundary Lubrication

Lecture 13 - Lubrication Mechanisms

Lecture 14 - Hydrodynamic Lubrication

Lecture 15 - Lubricant Classifications

Lecture 16 - Solid and Semi Solid Lubricants

Lecture 17 - Liquid Lubricants

Lecture 18 - Lubricant Additives

Lecture 19 - Fluid Film Lubrication

Lecture 20 - Reynolds Equation

Lecture 21 - Solution of Reynolds Equation

Lecture 22 - Hybrid Solution Approach (to solve Reynolds Equation)

Lecture 23 - Finite Difference Method to Solve Reynolds Equation

Lecture 24 - Viscosity Variation

Lecture 25 - Estimating Elastic Deformation

Lecture 26 - Thermo Hydrodynamic Lubrication

Lecture 27 - Application of Tribology

Lecture 28 - Rolling Element Bearings

Lecture 29 - Rolling Element Bearings (Continued...)

Lecture 30 - Rolling Element Bearings (Continued...)

Lecture 31 - Selection of Rolling Element Bearings

[Lecture 32 - Friction of Rolling Element Bearing](#)

[Lecture 33 - Bearing Clearance](#)

[Lecture 34 - Bearing Lubrication](#)

[Lecture 35 - Tribology of Gears](#)

[Lecture 36 - Friction and Lubrication of Gears](#)

[Lecture 37 - Friction and Lubrication of Gears \(Continued...\)](#)

[Lecture 38 - Surface Fatigue of Spur Gears](#)

[Lecture 39 - Journal Bearings](#)

[Lecture 40 - Hydrostatic Bearings](#)

[Lecture 41 - Hydrodynamic Journal Bearings](#)

[Lecture 42 - Design of Hydrodynamic Journal Bearings](#)

Lecture 1 - An Introduction to CAD

Lecture 2 - Input Output Devices, Raster Graphics

Lecture 3 - Raster Graphics - I

Lecture 4 - Raster Graphics - II

Lecture 5 - Polygon Filling

Lecture 6 - Windowing and Clipping

Lecture 7 - Clipping of Polygons

Lecture 8 - 2D Transformations

Lecture 9 - 3D Transformations and Projection

Lecture 10 - Perspective Projections

Lecture 11 - Projections and Hidden Surface Removal

Lecture 12 - Hidden Surface Removal

Lecture 13 - Hidden Surface Removal

Lecture 14 - Hidden Surface Removal

Lecture 15 - Finite Element Method : An Introduction

Lecture 16 - Galerkin's Approach

Lecture 17 - Galerkin's Method : 1D Finite Element Method

Lecture 18 - 1D Finite Element Problems

Lecture 19 - 1D Finite Element Problems

Lecture 20 - FE Problems : Solving for Q

Lecture 21 - 1D - FE Problems : Galerkin's Approach

Lecture 22 - Penalty Approach and Multi Point Boundary

Lecture 23 - Quadratic Shape Functions

Lecture 24 - 2D - FE Problems

Lecture 25 - 2D - FE Problems (Continued.)

Lecture 26 - 3D - FE Problems

Lecture 27 - 3D - Tetrahedral and 2D - Quadrilateral Element

Lecture 28 - Mesh Preparation

Lecture 29 - Modeling of Curves

Lecture 30 - Modeling of Curves

Lecture 31 - Modeling of Curves

[Lecture 32 - Modeling of B-Spline Curves](#)

[Lecture 33 - Modeling of B-spline Curves](#)

[Lecture 34 - Surface Modeling](#)

[Lecture 35 - Surface Modeling](#)

[Lecture 36 - Display of Curves and Surfaces](#)

[Lecture 37 - Solid Modeling](#)

[Lecture 38 - Solid Modeling](#)

[Lecture 39 - Solid Modeling Using Octrees](#)

[Lecture 40 - \(Lecture Missing\)](#)

[Lecture 41 - Computer Aided Design](#)

[Lecture 42 - Computer Aided Manufacturing](#)

[Lecture 43 - What is CAD/CAM](#)

[Lecture 44 - An Overview of Geometric Modeling](#)

[Lecture 45 - Parametric Cubic Curve](#)

[Lecture 46 - Parametric Bezier Curve](#)

[Lecture 47 - B-Spline Curve](#)

[Lecture 48 - Parametric Surfaces - Part-1](#)

[Lecture 49 - Parametric Surfaces - Part-2](#)

[Lecture 50 - Solid Modeling](#)

[Lecture 51 - Geometric & Product Data Exchange](#)

[Lecture 52 - Reverse Engineering](#)

**NPTEL : Project and Production Management (Mechanical Engineering)**

**Co-ordinators : Prof. Arun Kanda**

Lecture 1 - Project and Production Management - An Overview

Lecture 2 - Project Management: An Overview

Lecture 3 - Project Identification and Screening

Lecture 4 - Project Appraisal - Part I

Lecture 5 - Project Appraisal - Part II

Lecture 6 - Project Selection

Lecture 7 - Project Representation

Lecture 8 - Consistency and Redundancy in Project Networks

Lecture 9 - Basic scheduling with A-O-A Networks

Lecture 10 - Basic Scheduling with A-O-N Networks

Lecture 11 - Project Scheduling with Probabilistic Activity

Lecture 12 - Linear Time-Cost Tradeoffs in Projects

Lecture 13 - Project Crashing with Multiple Objectives

Lecture 14 - Resource Profiles and Leveling

Lecture 15 - Limited Resource Allocation

Lecture 16 - Project Monitoring and Control with PERT/Cost

Lecture 17 - Team Building and Leadership in Projects

Lecture 18 - Organizational and Behavioral Issues

Lecture 19 - Computers in Project Management

Lecture 20 - Project Completion and Review

Lecture 21 - Life Cycle of a Production System

Lecture 22 - Role of Models in Production Management

Lecture 23 - Financial Evaluation of capital Decisions

Lecture 24 - Decision Trees and Risk Evaluation

Lecture 25 - Introducing New Products & Services

Lecture 26 - Economic Evaluation of New Products & Services

Lecture 27 - Product Mix Decisions

Lecture 28 - Product & Process Design

Lecture 29 - Issues in Location of Facilities

Lecture 30 - Mathematical Models for Facility Location

Lecture 31 - Layout planning

[Lecture 32 - Computerised Layout Planning](#)

[Lecture 33 - Product Layouts and Assembly Line Balancing](#)

[Lecture 34 - Forecasting](#)

[Lecture 35 - The Analysis of Time Series](#)

[Lecture 36 - Aggregate Production Planning: Basic Concepts](#)

[Lecture 37 - Modelling Approaches](#)

[Lecture 38 - Basic Inventory Principles](#)

[Lecture 39 - Inventory Modelling](#)

[Lecture 40 - Material Requirements Planning](#)

[Lecture 41 - Scheduling of Job Shops](#)

Lecture 1 - Introduction to Design

Lecture 2 - Design Considerations

Lecture 3 - Basic Concepts Psychrometry and Air-Conditioning

Lecture 4 - Refrigerants

Lecture 5 - Refrigerant Properties and Applications

Lecture 6 - Refrigeration Cycle and Components

Lecture 7 - Compressor Selection

Lecture 8 - Expansion Devices

Lecture 9 - Condensers and Evaporators

Lecture 10 - Types of Heat Exchangers and Air Conditioning Systems

Lecture 11 - Selection of Air Conditioning Systems for Hostels

Lecture 12 - Case Study on a Railway Air Conditioning System

Lecture 13 - Vibration and noise issues in railway AC systems

Lecture 14 - New product launch process

Lecture 15 - Case study on a telecom cooling system and Emerging technologies



Lecture 1 - Thermodynamic Concepts: Applications of thermodynamics

Lecture 2 - Thermodynamic Concepts: System definition, Heat, Work and Mass Flow

Lecture 3 - Thermodynamic Concepts: Questions and Answers

Lecture 4 - Thermodynamic Concepts: Properties, State and Equilibrium

Lecture 5 - Thermodynamic Concepts: Process, Cycles and Applications

Lecture 6 - Thermodynamic Concepts: Steady state, Reversible and Irreversible processes

Lecture 7 - Thermodynamic Concepts: Causes of irreversibility

Lecture 8 - Thermodynamic Concepts: Thermal reservoirs

Lecture 9 - Thermodynamic Concepts: Pressure and temperature

Lecture 10 - Thermodynamic Concepts: Revision and Summary

Lecture 11 - Laws Of Thermodynamics: Mass flow rate, Conservation of mass, Flow work

Lecture 12 - Laws Of Thermodynamics: Zeroth Law

Lecture 13 - Laws Of Thermodynamics: First Laws Of Thermodynamics, 1st law for Control Mass, Internal Energy, enthalpy

Lecture 14 - Laws Of Thermodynamics: 1st law for Control Volume

Lecture 15 - Laws Of Thermodynamics: Revision, Cycles, Second Law statements, Clausius inequality

Lecture 16 - Laws Of Thermodynamics: Introduction to Carnot Cycle

Lecture 17 - Laws Of Thermodynamics: Entropy, Entropy change for a system

Lecture 18 - Laws Of Thermodynamics: Thermodynamics relations, Bernoulli's equation

Lecture 19 - Laws Of Thermodynamics: Devices, Cycles

Lecture 20 - Properties of a Pure Substance: Thermodynamic behaviour of a pure substance

Lecture 21 - Properties of a Pure Substance: Saturated states, Subcooled liquid, Superheated vapour

Lecture 22 - Properties of a Pure Substance: Vapour pressure curve, Reference state

Lecture 23 - Properties of a Pure Substance: Saturated states

Lecture 24 - Properties of a Pure Substance: p-h diagram

Lecture 25 - Properties of a Pure Substance: T-s diagram, h-s diagram

Lecture 26 - Properties of a Pure Substance: Critical state, Compressibility factor

Lecture 27 - Properties of a Pure Substance: Ideal gas behaviour, Equations of state, Specific heat

Lecture 28 - Properties of a Pure Substance: Ideal gas processes

Lecture 29 - Properties of a Pure Substance: Gibbs energy, Helmholtz function, Property relations

Lecture 30 - Properties of a Pure Substance: Process analysis, Summary

Lecture 31 - Laws of Thermodynamics: Carnot Cycle Realization

Lecture 32 - Applications, Problem Solving: Devices, Schematic/Flow Diagrams

Lecture 33 - Applications, Problem Solving: Positive Displacement Devices

Lecture 34 - Applications, Problem Solving: Heat Exchangers

Lecture 35 - Applications, Problem Solving: Compressors, Fans and Blowers, Pumps

Lecture 36 - Applications, Problem Solving: Turbines

Lecture 37 - Applications, Problem Solving: Nozzle, Diffuser, Expansion Valve, Pipe/duct flow

Lecture 38 - Applications, Problem Solving: De-Superheater, Deaerator, Separation

Lecture 39 - Applications, Problem Solving: Unsteady processes, Filling, Evacuation

Lecture 40 - Applications, Problem Solving: Realization of Carnot cycle, Practical cycles, Air-standard cycles

Lecture 41 - Applications, Problem Solving: Materials, Compressible flow

Lecture 42 - Applications, Problem Solving: Otto cycle, Diesel cycle

Lecture 43 - Applications, Problem Solving: Closed system

Lecture 44 - Applications, Problem Solving: Open System

Lecture 45 - Properties of Ideal Gas Mixtures: Introduction to mixtures properties

Lecture 46 - Properties of Ideal Gas Mixtures: Equation of state, Conservation equations

Lecture 47 - Gas-Vapour Mixtures: Psychrometry, Moist air Properties,

Lecture 48 - Gas-Vapour Mixtures: Properties, Conservation of Mass and Energy

Lecture 49 - Gas-Vapour Mixtures: Psychrometric chart, Applications

Lecture 50 - Thermodynamics of Reacting systems: Introduction to reacting systems and combustion

Lecture 51 - Thermodynamics of Reacting systems: Flames, Stoichiometry

Lecture 52 - Thermodynamics of Reacting systems: Analysis of Closed and Open Systems, Enthalpy of Formation

Lecture 53 - Phase and Chemical Equilibrium: Introduction. Chemical equilibrium. Gibbs function

Lecture 54 - Phase and Chemical Equilibrium: Equilibrium constant. Phase equilibrium

- Lecture 1 - Mathematical Concepts: Working with Vectors and Tensors
- Lecture 2 - Traction Vector
- Lecture 3 - Stress Tensor and its Matrix Representation
- Lecture 4 - Transformation of Stress Matrix
- Lecture 5 - Stress Equilibrium Equations : Balance of Linear and Angular Momentum
- Lecture 6 - Balance of Angular Momentum (Continued...)
- Lecture 7 - Principal Planes and Principal stress components
- Lecture 8 - Maximizing the Shear Component of Traction
- Lecture 9 - Mohr's Circle
- Lecture 10 - Mohr's Circle (Continued...), Stress Invariants, Decomposition of the Stress Tensor
- Lecture 11 - Concept of Strain Tensor
- Lecture 12 - Longitudinal and Shear Strains
- Lecture 13 - Local Volumetric Strain and Local Infinitesimal Rotation
- Lecture 14 - Similarity in Properties of Stress and Strain Tensors
- Lecture 15 - Stress-Strain Relation
- Lecture 16 - Stress-Strain Relation for Isotropic Materials
- Lecture 17 - Linear Momentum Balance in Cylindrical Coordinate System
- Lecture 18 - Linear Momentum Balance in Cylindrical Coordinate System (Continued...)
- Lecture 19 - Strain Matrix Cylindrical Coordinate System
- Lecture 20 - Extension-Torsion-Inflation in a Hollow Cylinder
- Lecture 21 - Extension-Torsion-Inflation in a Hollow Cylinder (Continued...)
- Lecture 22 - Solving Problems Involving Torsion of Shafts
- Lecture 23 - Pure Bending of Rectangular Beams
- Lecture 24 - Bending of Beams (Continued...)
- Lecture 25 - Bending of Unsymmetrical Beams
- Lecture 26 - Concept of Shear Center
- Lecture 27 - Theory of Beams
- Lecture 28 - Theory of Beams (Continued...) and Beam Buckling
- Lecture 29 - Energy Methods
- Lecture 30 - Energy Methods (Continued...)
- Lecture 31 - Theories of Failure

[Lecture 32 - Theories of Failure \(Continued...\)](#)

- Lecture 1 - Course Outline, Introduction
- Lecture 2 - Experimentation Processes and Applications Overview
- Lecture 3 - Developments in Uncertainty Analysis, Approach
- Lecture 4 - Errors, Their Causes and Classification
- Lecture 5 - Errors to Uncertainty via Statistics
- Lecture 6 - Sources of Errors, Uncertainty Definitions
- Lecture 7 - Experimentation - I
- Lecture 8 - Experimentation Stages / Phases I
- Lecture 9 - Experimentation Stages / Phases II
- Lecture 10 - Uncertainty Analysis Processes
- Lecture 11 - Instrument ans DAS
- Lecture 12 - Basic procedure - I
- Lecture 13 - Basic procedure - II
- Lecture 14 - Evaluating systematic uncertainties
- Lecture 15 - Worksheets for uncertainty in a measurement, Examples
- Lecture 16 - Examples of uncertainty in a measurement
- Lecture 17 - Methodologies, Multiple tests method
- Lecture 18 - Single test, Basics of Taylor Series Method
- Lecture 19 - Sensitivity coefficient, Result uncertainty from TSM
- Lecture 20 - Result uncertainty TSM: Special cases
- Lecture 21 - Method selection, Worksheets for result uncertainty
- Lecture 22 - Examples for result uncertainty - 1
- Lecture 23 - Examples for result uncertainty - 2
- Lecture 24 - Regression Introduction
- Lecture 25 - Regression analysis - Linear, single variable
- Lecture 26 - Correlation, Related topics
- Lecture 27 - Reporting uncertainties
- Lecture 28 - Validation and verification aspects, Data archiving
- Lecture 29 - Course overview

Lecture 1 - Introduction

Lecture 2 - Examples of visualization - 1

Lecture 3 - Examples of visualization - 2

Lecture 4 - Visualization and drawing

Lecture 5 - Sketch to engineering drawing

Lecture 6 - Types of projections

Lecture 7 - Multiview projections

Lecture 8 - 1st and 3rd angle projections

Lecture 9 - Sketching

Lecture 10 - Visualization

Lecture 11 - Drawing sheet

Lecture 12 - Lines

Lecture 13 - Dimensioning

Lecture 14 - Projection of a point line and plane

Lecture 15 - Projection of simple objects

Lecture 16 - Example Projection of a solid

Lecture 17 - Example Projection of an object

Lecture 18 - Types of Solids

Lecture 19 - Polygons Construction and Projections

Lecture 20 - Rotation of Solids

Lecture 21 - Example Rotation of Solids

Lecture 22 - Section views

Lecture 23 - Sectioning practices

Lecture 24 - Auxiliary views

Lecture 25 - Example Section View

Lecture 26 - Example Auxiliary View

Lecture 27 - Pictorial Drawings

Lecture 28 - Construction of Isometric Drawings

Lecture 29 - Example Isometric drawings

Lecture 30 - Working Drawing

Lecture 31 - Example Sectional View of Assembly

[Lecture 32 - Computer Aided Design](#)

[Lecture 33 - Autodesk Inventor Environment](#)

[Lecture 34 - Sketching for Solid Modelling](#)

[Lecture 35 - Example 1 Extrude Hole Fillet Chamfer](#)

[Lecture 36 - Example 2 Rib Mirror](#)

[Lecture 37 - Example 3](#)

[Lecture 38 - Revolve Loft Pattern](#)

[Lecture 39 - Example 4](#)

[Lecture 40 - Example 5](#)

[Lecture 41 - Spline Sweep Shell](#)

[Lecture 42 - Example 6](#)

[Lecture 43 - Example 7](#)

[Lecture 44 - Drawing from Solid Model](#)

[Lecture 45 - Assembly with constraints](#)

[Lecture 46 - Example 8](#)

[Lecture 47 - Example 9](#)

[Lecture 48 - Example 10](#)

[Lecture 49 - Example 11](#)

[Lecture 50 - Civil and architectural drawings](#)

Lecture 1 - Ideal fluids, Velocity potential, Potential flows

Lecture 2 - Stream function, Orthogonality of streamlines and equipotential lines

Lecture 3 - Complex variables, Analyticity, Cauchy - Riemann equations, Complex potential, Complex velocity

Lecture 4 - Elementary flows : Uniform flow, Source and Sink, Free vortex

Lecture 5 - Flow in a bend, Flow around a sharp edge

Lecture 6 - Superposition of source and sink : doublet flow

Lecture 7 - Superposition of uniform flow and doublet

Lecture 8 - Superposition of uniform flow, doublet and free vortex

Lecture 9 - Superposition of source and uniform flow

Lecture 10 - Problem solving session - 1

Lecture 11 - Problem solving session - 2

Lecture 12 - Method of images, Forces on a body, Blasius theorem

Lecture 13 - Calculation of forces using derived flow field

Lecture 14 - Introduction to conformal transformation

Lecture 15 - Singularities and their transformations



[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10](#)

[Lecture 11](#)

[Lecture 12](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

[Lecture 20](#)

[Lecture 21](#)

[Lecture 22](#)

[Lecture 23](#)

[Lecture 24](#)

[Lecture 25](#)

[Lecture 26](#)

[Lecture 27](#)

[Lecture 28](#)

[Lecture 29](#)

[Lecture 30](#)

[Lecture 31](#)

[Lecture 32](#)

[Lecture 33](#)

[Lecture 34](#)

[Lecture 35](#)

[Lecture 36](#)

[Lecture 37](#)

[Lecture 38](#)

[Lecture 39](#)

[Lecture 40](#)

- Lecture 1 - Introduction to polymers
- Lecture 2 - Polymer structure
- Lecture 3 - Polymer classification
- Lecture 4 - Polymer length, packing and tacticity
- Lecture 5 - Glass transition temperature
- Lecture 6 - Temperature effects, glassy regime
- Lecture 7 - Viscoelastic, rubbery, viscous, decomposition
- Lecture 8 - Relaxation and creep tests
- Lecture 9 - Failure of polymers
- Lecture 10 - Heaviside, Dirac delta, Laplace
- Lecture 11 - Introduction to linear viscoelasticity
- Lecture 12 - Phenomenological models for linear viscoelasticity
- Lecture 13 - Maxwell model
- Lecture 14 - Kelvin model
- Lecture 15 - Three and four parameter models
- Lecture 16 - Generalized Maxwell and Kelvin models
- Lecture 17 - Boltzman superposition principle
- Lecture 18 - Alfrey's correspondence principle
- Lecture 19 - Analysis of viscoelastic bars
- Lecture 20 - Analysis of viscoelastic beams
- Lecture 21 - Dynamic mechanical analysis (DMA)
- Lecture 22 - Dynamic mechanical thermal analysis (DMTA)
- Lecture 23 - Time temperature superposition principle (TTSP)
- Lecture 24 - Plastic design consideration and practices
- Lecture 25 - What are composites?
- Lecture 26 - Composite materials and types
- Lecture 27 - Composite advantages and applications
- Lecture 28 - Fabrication and other aspects of composites
- Lecture 29 - 3D stress and strain components
- Lecture 30 - Symmetry in stress, strain and stiffness matrix
- Lecture 31 - Monoclinic, orthotropic and isotropic materials

- Lecture 32 - 3D stress strain relation for orthotropic material
- Lecture 33 - Plane stress: Specially orthotropic material
- Lecture 34 - Plane stress: Generally orthotropic material
- Lecture 35 - Lamina engineering constants
- Lecture 36 - Lamina hygrothermal effects
- Lecture 37 - Lamina fundamental strengths
- Lecture 38 - Lamina failure criteria
- Lecture 39 - Tsai-Hill and Hoffman failure criteria
- Lecture 40 - Micromechanics: Assumptions, RVE
- Lecture 41 - Micromechanics: Stiffness prediction
- Lecture 42 - Micromechanics: Stiffness and strength
- Lecture 43 - Macromechanics of laminate
- Lecture 44 - Classical laminate theory
- Lecture 45 - Classical laminate theory - II
- Lecture 46 - Symmetric laminates, orthotropic laminates
- Lecture 47 - Angle-ply, cross-ply and quasi-isotropic laminates
- Lecture 48 - Hygrothermal stresses in laminates
- Lecture 49 - Laminate failure
- Lecture 50 - Design practices with laminates
- Lecture 51 - Sandwich structures
- Lecture 52 - Composites testing
- Lecture 53 - Joining of composites

- Lecture 1 - Introduction to Tribology
- Lecture 2 - Tribological Interfaces
- Lecture 3 - Fundamentals of Friction and Wear
- Lecture 4 - Adhesion, Abrasion, and Surface Fatigue Mechanisms
- Lecture 5 - Wear Measurement Techniques
- Lecture 6 - Principles of Lubrication, types of Lubricants and their properties
- Lecture 7 - Lubrication regimes and film thickness calculations
- Lecture 8 - Mixed Lubrication
- Lecture 9 - Hydrodynamic Lubrication Theory
- Lecture 10 - Design Considerations for Hydrodynamic Lubrication Systems
- Lecture 11 - Elastohydrodynamic Lubrication
- Lecture 12 - Solid Lubrication
- Lecture 13 - Surface modification techniques for tribological applications
- Lecture 14 - Thin film coatings and their tribological properties
- Lecture 15 - Nanotribology
- Lecture 16 - Tribocorrosion
- Lecture 17 - Wear testing techniques and standards
- Lecture 18 - Measurement and analysis of wear debris
- Lecture 19 - Experimental Design and Statistical Analysis
- Lecture 20 - Introduction to Data-Enabled Engineering
- Lecture 21 - Data Collection and Preprocessing
- Lecture 22 - Feature Extraction and Selection
- Lecture 23 - Introduction to Machine Learning Algorithms
- Lecture 24 - Regression and Classification Algorithms for Tribological Modeling
- Lecture 25 - Deep Learning for Tribological Engineering
- Lecture 26 - Data-Driven Models for Friction Prediction
- Lecture 27 - Data-Driven Models for Wear Prediction
- Lecture 28 - Data-Driven Models for Lubricant Optimization
- Lecture 29 - Data-Driven Models for Tribofilm Formation
- Lecture 30 - Data-Driven Models for Tribocorrosion Prediction
- Lecture 31 - Prediction of Coating and Surface Treatment Performance

[Lecture 32 - Optimization of Surface Engineering Processes using Machine Learning](#)

[Lecture 33 - Uncertainty Quantification and Sensitivity Analysis](#)

[Lecture 34 - Data Management and Ethics in Data-Enabled Engineering](#)

[Lecture 35 - Case Studies in Data-Enabled Tribological Engineering](#)

[Lecture 36 - Future Directions in Data-Enabled Tribological Engineering](#)

**NPTEL : Nonlinear Vibration (Mechanical Engineering)**

**Co-ordinators : Prof. S.K. Dwivedy**

Lecture 1 - Introduction of Nonlinear systems

Lecture 2 - Review of Linear vibrating systems

Lecture 3 - Phenomena associated with Nonlinear systems

Lecture 4 - Commonly observed Phenomena in Nonlinear systems

Lecture 5 - Force and Moment based Approach

Lecture 6 - Energy based approach Extended Hamilton's principle and Lagrange Principle

Lecture 7 - Derivation of Equation of motion of nonlinear discrete system (More examples)

Lecture 8 - Derivation of Equation of motion of nonlinear continuous system - 1

Lecture 9 - Derivation of Equation of motion of nonlinear continuous system - 2

Lecture 10 - Ordering of nonlinear Equation of motion

Lecture 11 - Qualitative Analysis Straight forward expansion

Lecture 12 - Numerical method Straight forward expansion

Lecture 13 - Lindstedt Poincaré technique

Lecture 14 - Method of multiple scales

Lecture 15 - Method of Harmonic balance

Lecture 16 - Method of averaging

Lecture 17 - Generalized Method of averaging

Lecture 18 - Krylov-Bogoliubov-Mitropolski technique

Lecture 19 - Incremental harmonic balance method and Intrinsic multiple scale harmonic balance method

Lecture 20 - Modified Lindstedt Poincaré technique

Lecture 21 - Stability and Bifurcation of Fixed-point response - 1

Lecture 22 - Stability and Bifurcation of Fixed-point response - 2

Lecture 23 - Stability and Bifurcation of Fixed-point response - 3

Lecture 24 - Stability and Bifurcation of Fixed-point response - 4

Lecture 25 - Stability Analysis of Periodic response

Lecture 26 - Bifurcation of Periodic response And Introduction to quasi-periodic and Chaotic response

Lecture 27 - Quasi-Periodic and Chaotic response

Lecture 28 - Numerical methods to obtain roots of characteristic equation and time response

Lecture 29 - Numerical methods to obtain time response

Lecture 30 - Numerical methods to obtain frequency response

Lecture 31 - Free Vibration of Single degree of freedom Nonlinear systems with Cubic and quadratic nonlinearities

[Lecture 32 - Free Vibration of Single degree of freedom Nonlinear systems with Cubic and quadratic nonlinearities: effect of damping](#)

[Lecture 33 - Free Vibration of multi- degree of freedom Nonlinear systems with Cubic and quadratic nonlinearities](#)

[Lecture 34 - Forced nonlinear Vibration Single degree of freedom Nonlinear systems with Cubic nonlinearities:](#)

[Lecture 35 - Forced nonlinear Vibration Single and multi- degree of freedom Nonlinear systems](#)

[Lecture 36 - Nonlinear Forced-Vibration of Single and Multi Degree-of-Freedom System](#)

[Lecture 37 - Analysis of Multi- degree of freedom system](#)

[Lecture 38 - Nonlinear Vibration of Parametrically excited system: Axially loaded sandwich beam](#)

[Lecture 39 - Nonlinear Vibration of Parametrically excited system: Elastic and Magneto-elastic beam](#)

[Lecture 40 - Nonlinear Vibration of Parametrically excited system with internal resonance](#)



Lecture 1 - Introduction

Lecture 2 - A Brief History of Rotor Dynamics

Lecture 3 - The State of the Art of Rotor Dynamics

Lecture 4 - Simple Rotor Models with Rigid Bearings

Lecture 5 - Jeffcott Rotor Model

Lecture 6 - Variant of Jeffcott Rotor Model

Lecture 7 - Rigid Rotor Mounted on Simple Anisotropic Springs as Bearings

Lecture 8 - Rigid Rotor Mounted on Complex Anisotropic Bearings

Lecture 9 - Flexible Shaft with a Rigid Disc Mounted on Anisotropic Supports

Lecture 10 - Gyroscopic Effects : Synchronous whirl of a Rotor Systems with a thin Disc

Lecture 11 - Gyroscopic Effects : Synchronous and Asynchronous pure wobbling motions

Lecture 12 - Gyroscopic Effects : Asynchronous whirl of a Rotor system with a thin Disc

Lecture 13 - Gyroscopic Effects : Asynchronous whirl analysis with Dynamic Approach

Lecture 14 - Torsional Vibrations: Simple Rotor Systems

Lecture 15 - Three Disc Rotor System

Lecture 16 - Transfer Matrix Approach - Part I

Lecture 17 - Transfer Matrix Approach - Part II

Lecture 18 - Transfer Matrix Approach - Part III

Lecture 19 - Geared and Branched Systems

Lecture 20 - Continuous System and Finite Element Method

Lecture 21 - Finite Element Method

Lecture 22 - Finite Element Analysis

Lecture 23 - Finite Element Analysis - Part III

Lecture 24 - Influence Coefficient Method

Lecture 25 - Transfer Matrix Method - Part I

Lecture 26 - Transfer Matrix Method - Part II

Lecture 27 - Transfer Matrix Method - Part III

Lecture 28 - Continuous System Approach

Lecture 29 - Finite Element Method - Part I

Lecture 30 - Finite Element Method - Part II

Lecture 31 - Finite Element Method - Part III

[Lecture 32 - Instability in Rotor Systems: Bearings](#)

[Lecture 33 - Fluid-Film Bearings](#)

[Lecture 34 - Internal Damping & Asymmetrical Shaft](#)

[Lecture 35 - Steam Whirl and Seals](#)

[Lecture 36 - Subcritical Speed Whirl](#)

[Lecture 37 - Introduction to Rigid Rotor Balancing](#)

[Lecture 38 - Dynamic Balancing of Rotors: Rigid Rotor Balancing](#)

[Lecture 39 - Dynamic Balancing of Rotors:Flexible Rotor Model Balancing](#)

[Lecture 40 - Dynamic Balancing of Rotors:Influence Coefficient Method for Flexible Rotor](#)

[Lecture 41 - Common Faults & Vibration signatures](#)

[Lecture 42 - Condition Based Monitoring](#)

Lecture 1 - Fundamentals Of Engineering Mechanics

Lecture 2 - Equations of Equilibrium

Lecture 3 - Truss Analysis - Part 1

Lecture 4 - Truss Analysis - Part 2

Lecture 5 - Analysis of Frames Machines

Lecture 6 - Internal Forces

Lecture 7 - Internal Forces in Beams

Lecture 8 - Cables

Lecture 9 - Friction

Lecture 10 - Application of Friction - Part 1

Lecture 11 - Application of Friction - Part 2

Lecture 12 - Application of Friction - Part 3

Lecture 13 - Centroids Center of Mass

Lecture 14 - Centroids Area of Moments

Lecture 15 - Product of Inertia, Rotation of Axis and Principle Moments of Inertia

Lecture 16 - Principle Mass Moments of Inertia

Lecture 17 - Second Moment of Mass

Lecture 18 - Virtual Work of Ideal System

Lecture 19 - Principle of Virtual Work

Lecture 20 - Systems with Friction

Lecture 21 - Potential Energy

Lecture 22 - Stability of Equilibrium

Lecture 23 - Kinematics of a Particles

Lecture 24 - Kinematics of a Particle Moving on a Curve

Lecture 25 - Relative Motion

Lecture 26 - Plane Kinematics of Rigid Bodies

Lecture 27 - Kinematics of a Particle

Lecture 28 - Work and Energy

Lecture 29 - Impulse and Momentum

Lecture 30 - Direct and Oblique Impulse

Lecture 31 - Plane Kinetics of Rigid Bodies

[Lecture 32 - Kinetics of a Body](#)

[Lecture 33 - Method of Momentum and Analysis of Robot Manipulator](#)

[Lecture 34 - Kinematics in 3D](#)

[Lecture 35 - Kinetics in 3D](#)

[Lecture 36 - Free Vibration](#)

[Lecture 37 - Forced Vibration Damped Undamped](#)

[Lecture 38 - Vibration of Rigid Bodies - Part 1](#)

[Lecture 39 - Vibration of Rigid Bodies - Part 2](#)

[Lecture 40 - Some Problems of Vibration](#)

**NPTEL : Mechanical Vibrations (Mechanical Engineering)**

**Co-ordinators : Prof. S.K. Dwivedy, Prof. Rajiv Tiwari**

- Lecture 1 - Overview of the Course, Practical and Research Trends
- Lecture 2 - Harmonic and Periodic Motions, Vibration Terminology
- Lecture 3 - Vibration Model, Equation of Motion-Natural Frequency
- Lecture 4 - Energy Method, Principle of Virtual Work
- Lecture 5 - Viscously Damped Free Vibration Special Cases: Oscillatory
- Lecture 6 - Logarithmic Decrement Experimental Determination of Damping Coefficient Hysteresis Loop
- Lecture 7 - Coulomb Damping other Damping Models
- Lecture 8 - Forced Harmonic Vibration, Magnification Factor
- Lecture 9 - Laplace Transform, Superposition Theorem
- Lecture 10 - Rotor Unbalance and Whirling of Shaft, Transmissibility
- Lecture 11 - Support Motion, Vibration Isolation
- Lecture 12 - Sharpness of Resonance, Vibration Measuring Instruments
- Lecture 13 - Generalized and Principle Coordinates, Derivation of Equation of Motion
- Lecture 14 - Lagranges's Equation
- Lecture 15 - Coordinate Coupling
- Lecture 16 - Forced Harmonic Vibration
- Lecture 17 - Tuned Absorber, Determination of Mass Ratio
- Lecture 18 - Tuned and Damped Absorber, Untuned Viscous Damper
- Lecture 19 - Derivation of Equations of Motion, Influence Coefficient Method
- Lecture 20 - Properties of Vibrating Systems: Flexibility & Stiffness Matrices, Reciprocity Theorem
- Lecture 21 - Modal Analysis: Undamped
- Lecture 22 - Modal Analysis: Damped
- Lecture 23 - Simple Systems With One Two or Three Discs Geared System
- Lecture 24 - Multi-Degree of Freedom Systems-Transfer Matrix Method Branched Systems
- Lecture 25 - Derivation of Equations of Motion Part 1 - Newton
- Lecture 26 - Derivation of Equations of Motion Part 2 - Newton
- Lecture 27 - Vibration of Strings
- Lecture 28 - Longitudinal and Torsional Vibration of Rods
- Lecture 29 - Transverse Vibration of Beams, Equations of Motion and Boundary Conditions
- Lecture 30 - Transverse Vibration of Beams: Natural Frequencies and Mode Shapes
- Lecture 31 - Rayleigh's Energy Method

[Lecture 32 - Matrix Iteration Method](#)

[Lecture 33 - Durkerley, Rayleigh-Ritz and Galerkin Method](#)

[Lecture 34 - Finite Element Formulation for Rods, Gear Train and Branched System](#)

[Lecture 35 - Finite Element Formulation for Beams: Galerkin](#)

[Lecture 36 - Global Finite Element Assembly and Imposition of Boundary Conditions](#)

[Lecture 37 - Vibration Testing Equipments: Signal Measurements](#)

[Lecture 38 - Vibration Testing Equipments: Signal Analysis](#)

[Lecture 39 - Field Balancing of Rotors](#)

[Lecture 40 - Condition Monitoring](#)

Lecture 1 - Introduction to advanced machining processes

Lecture 2 - Ultrasonic machining - Part I

Lecture 3 - Ultrasonic machining - Part II

Lecture 4 - Abrasive jet machining

Lecture 5 - Water jet cutting and Abrasive water jet machining

Lecture 6 - Magnetic abrasive finishing

Lecture 7 - Abrasive Flow Finishing

Lecture 8 - Magnetorheological Finishing

Lecture 9 - Magnetorheological Abrasive Flow Finishing - Part I

Lecture 10 - Magnetorheological Abrasive Flow Finishing - Part II

Lecture 11 - Magnetorheological Abrasive Flow Finishing - Part III

Lecture 12 - Electric discharge machining (EDM)

Lecture 13 - Electric Discharge Grinding, Electric Discharge Diamond Grinding and Wire Electric Discharge Machining

Lecture 14 - Electrochemical Machining (ECM)

Lecture 15 - Electrochemical Grinding, Electrostream Drilling, Shaped Tube Electrolytic Machining

Lecture 16 - Plasma Arc Machining (PAM)

Lecture 17 - Electron Beam Machining (EBM) Edit Lesson

Lecture 18 - Laser Beam Machining (LBM)

Lecture 19 - Chemical Machining (ChM)

- Lecture 1 - Introduction of nuclear energy
- Lecture 2 - Binding energy and mass defect
- Lecture 3 - Radioactivity and radioactive decay
- Lecture 4 - Different types of nuclear transmutation
- Lecture 5 - Artificial radioactivity and neutron-nucleus interactions
- Lecture 6 - Energy and momentum conservation
- Lecture 7 - Fission and role of neutron energy
- Lecture 8 - Theory of elastic scattering
- Lecture 9 - Neutron multiplication factor
- Lecture 10 - Neutron diffusion theory
- Lecture 11 - Solution of one-group diffusion equation
- Lecture 12 - Simple reactor theory
- Lecture 13 - Nuclear fuel and simple energy consideration
- Lecture 14 - Axial temperature distribution and heat transfer coefficient
- Lecture 15 - Prompt and delayed neutrons
- Lecture 16 - Delayed neutron kinetics
- Lecture 17 - Different control mechanisms and various effects
- Lecture 18 - Classical reactor designs
- Lecture 19 - Evolution of reactors from Gen-I to Gen-IV
- Lecture 20 - The concept of breeding
- Lecture 21 - Fuel cycles and FBR
- Lecture 22 - Gen-IV FBR designs
- Lecture 23 - Hydrogen fusion reactions
- Lecture 24 - Coulomb barrier and other critical factors
- Lecture 25 - Radiation dose and gross biological effects
- Lecture 26 - Stochastic and deterministic effects of human cells
- Lecture 27 - Lessons from TMI and Chernobyl
- Lecture 28 - Defence-in-depth Philosophy
- Lecture 29 - Waste classification and Disposal of Mill Tailings
- Lecture 30 - Disposal methodologies for HLW and IMW



- Lecture 1 - Fundamentals of Welding and Joining - Part I
- Lecture 2 - Fundamentals of Welding and Joining - Part II
- Lecture 3 - Fundamentals of Welding and Joining - Part III
- Lecture 4 - Fundamentals of Welding and Joining - Part IV
- Lecture 5 - Fundamentals of Welding and Joining - Part V
- Lecture 6 - Laser and Electron Beam Welding - Part I
- Lecture 7 - Laser and Electron Beam Welding - Part II
- Lecture 8 - Solid State Welding Processes - Part I
- Lecture 9 - Solid State Welding Processes - Part II
- Lecture 10 - Solid State Welding Processes - Part III
- Lecture 11 - Computational Welding Mechanics - Part I
- Lecture 12 - Computational Welding Mechanics - Part II
- Lecture 13 - Computational Welding Mechanics - Part III
- Lecture 14 - Micro and Nano Joining Processes - Part I
- Lecture 15 - Micro and Nano Joining Processes - Part II
- Lecture 16 - Micro and Nano Joining Processes - Part III
- Lecture 17 - Welding Metallurgy - Part I
- Lecture 18 - Welding Metallurgy - Part II
- Lecture 19 - Welding Metallurgy - Part III
- Lecture 20 - Welding Metallurgy - Part IV
- Lecture 21 - Welding and Joining of Non-Metals - Part I
- Lecture 22 - Welding and Joining of Non-Metals - Part II
- Lecture 23 - Metal Transfer in Welding and Metal Printing

Lecture 1 - Introduction

Lecture 2 - Introduction and Importance of Machining

Lecture 3 - Principles of Machining or Metal Cutting

Lecture 4 - Cutting Tools

Lecture 5 - Forces in Machining

Lecture 6 - Tribology in Machining

Lecture 7 - Lubrication surface roughness in Machining

Lecture 8 - Machinability and Thermal Aspects

Lecture 9 - Tool Wear and Tool life - Part 1

Lecture 10 - Tool Wear and Tool life - Part 2

Lecture 11 - Tool Wear and Tool life - Part 3

Lecture 12 - Tool Materials and Coatings

Lecture 13 - Machining Fluids / Cutting Fluids and its Additives - Part 1

Lecture 14 - Machining Fluids / Cutting Fluids and its Additives - Part 2

Lecture 15 - Machining Fluids / Cutting Fluids and its Emissions

Lecture 16 - Eco Friendly Cutting Fluids - Part 1

Lecture 17 - Eco Friendly Cutting Fluids - Part 2

Lecture 18 - Rheology and Thermal Characterization of Machining / Cutting Fluids

Lecture 19 - Bio-degradation Studies of Machining / Cutting Fluids

Lecture 20 - Cutting Fluid Application in Machining Region

Lecture 21 - Practical Machining Processes - 1

Lecture 22 - Practical Machining Processes - 2

Lecture 23 - Introduction to Abrasive Processes - Grinding

Lecture 24 - Cutting fluids in Grinding Process

Lecture 25 - Unbonded Conventional Abrasive Processes

Lecture 26 - Advances in Metal Cutting\_Machining Processes

Lecture 27 - Advances in Metal Cutting\_Machining Processes - 2

Lecture 1 - Deformation of Metals

Lecture 2 - Mechanism of Plastic Deformation

Lecture 3 - Machining Processes: Single Edge Tool, Types of Chips

Lecture 4 - Tool Geometry: Single Point Cutting Tool Specifications

Lecture 5 - Tool Specifications, Conversion Of Tool Angles, Multi-Point Cutting Tools

Lecture 6 - Mechanics of Orthogonal Cutting, Force Relationships

Lecture 7 - Determination of Stress, Strain, and Strain Rate

Lecture 8 - Measurement of Shear Angle

Lecture 9 - Other Analysis for Force Relationships

Lecture 10 - Mechanics of Oblique Cutting

Lecture 11 - Measurement of Cutting Forces

Lecture 12 - Thermal Aspects Of Machining: Temperatures in Orthogonal Cutting

Lecture 13 - Tool Wear and Tool Life and Tool Life Equations

Lecture 14 - Economics in Machining

Lecture 15 - Practical Machining Operations: Turning And Shaping and Planning Operation

Lecture 16 - Practical Machining Operations: Milling And Drilling

Lecture 17 - Grinding of Metals and Mechanics of Grinding Process

Lecture 18 - Abrasive Machining and Finishing Operations

Lecture 19 - CNC Machines and CNC Programming

Lecture 20 - Introduction to Advanced Machining Processes

Lecture 1 - Introduction to hydraulic machines: classifications and operational principles

Lecture 2 - Euler equation for turbomachines: net head developed by the pump/turbines

Lecture 3 - Velocity triangles of pumps, effect of inlet swirl on pump operation

Lecture 4 - Velocity triangles of pumps, effect of inlet swirl on pump operation

Lecture 5 - Pump casings, Efficiencies and Problems - I

Lecture 6 - Pump casings, Efficiencies and Problems - II

Lecture 7 - Pump casings, Efficiencies and Problems - III

Lecture 8 - Axial flow pump, HQ curve, System Resistance Curve - I

Lecture 9 - Axial flow pump, HQ curve, System Resistance Curve - II

Lecture 10 - HQ Curve, System Resistance Curve - I

Lecture 11 - HQ Curve, System Resistance Curve - II

Lecture 12 - Introduction to Cavitation

Lecture 13 - Condition for Cavitation and NPSH

Lecture 14 - Net Positive Suction Head (NPSH)

Lecture 15 - Suction number and Introduction to off design condition

Lecture 16 - Cavitation: The effect of off-design Conditions

Lecture 17 - Cavitation: Preventive Measures

Lecture 18 - Cavitation: Preventive Measures, Effect on Pump Characteristic

Lecture 19 - Problems on Cavitation

Lecture 20 - Introduction to Slip : Stodola Slip Model

Lecture 21 - Departure from Euler theory

Lecture 22 - Slip Velocity - I

Lecture 23 - Slip Velocity - II

Lecture 24 - Problem on slip

Lecture 25 - Degree of reaction of pump

Lecture 26 - Degree of reaction and axial pump design

Lecture 27 - Testing of radial flow pump - I

Lecture 28 - Testing of radial flow pump - II

Lecture 29 - Problem on radial flow pump testing

Lecture 30 - Radial equilibrium of axial flow pump - I

Lecture 31 - Radial equilibrium of axial flow pump - II

- Lecture 32 - Pump operation: series and parallel connection
- Lecture 33 - Series and parallel operation of dissimilar pumps
- Lecture 34 - Pumping system design
- Lecture 35 - Design of parallel pumping system
- Lecture 36 - Numerical problem on pumps - I
- Lecture 37 - Numerical problem on pumps - II
- Lecture 38 - Numerical problem on pumps - III
- Lecture 39 - Working principle and Indicator diagram of PD pump
- Lecture 40 - Working principle and Indicator diagram of PD pump (Continued...)
- Lecture 41 - Modified indicator diagram and Head-Discharge curve
- Lecture 42 - Analysis and Head-Discharge curve of PD pump
- Lecture 43 - Analysis and efficiencies of PD pump
- Lecture 44 - Requirement of air chamber in PD pump
- Lecture 45 - Numerical problem on PD pump with air chamber
- Lecture 46 - Similarity and dimensional analysis of hydraulic machines
- Lecture 47 - Dimensional analysis of hydraulic machines: Buckingham's theorem
- Lecture 48 - Buckingham's theorem: Specific speed of hydraulic machines
- Lecture 49 - Turbine Classification and Operational principle of Pelton wheel
- Lecture 50 - Velocity Triangles and analysis
- Lecture 51 - Operational Principle of Reaction turbine
- Lecture 52 - Degree of Reaction and Introduction to axial flow turbine
- Lecture 53 - Kaplan Turbine: Operational Principle, Turbine efficiencies
- Lecture 54 - Draft Tube for Reaction Turbine and Cavitation
- Lecture 55 - Energy Balance and NPSH
- Lecture 56 - Thoma Cavitation Factor
- Lecture 57 - Reaction Turbine: Design aspects and Characteristic Curves
- Lecture 58 - Problems on Impulse and Reaction Turbines

- Lecture 1 - Introduction to Abrasive Machining and Finishing Processes
- Lecture 2 - Grinding Process
- Lecture 3 - Grinding Fluids and Its Additives
- Lecture 4 - Grinding Fluids and its Emissions
- Lecture 5 - Sustainable Grinding Process: Biodegradation of Grinding Fluids
- Lecture 6 - Sustainable Grinding Process: MQL in Grinding Process
- Lecture 7 - Honing Process
- Lecture 8 - Lapping Process
- Lecture 9 - Super Finishing and Sand Blasting
- Lecture 10 - Vibratory Bowl Finishing, Rotary Barrel Finishing or Tumbling
- Lecture 11 - Drag Finishing, Ice-bonded Abrasive Finishing, Pitch Polishing, Pad Polishing
- Lecture 12 - Introduction to Surface Texture in abrasive Process
- Lecture 13 - Representation of Surface Roughness
- Lecture 14 - Abrasive Jet Machining (AJM)
- Lecture 15 - Abrasive Water Jet Machining (AWJM)
- Lecture 16 - Ultrasonic Machining (USM)
- Lecture 17 - EDM, Wire-EDM, EDG, EDDG, AW-EDG
- Lecture 18 - Elastic Emission Machining
- Lecture 19 - PMEDM and ECD and ELID, ECH
- Lecture 20 - Abrasive Flow Finishing: Part 1
- Lecture 21 - Abrasive Flow Finishing: Part 2
- Lecture 22 - Magnetic Field Assisted Abrasive Finishing: MAF, MADe, MFP
- Lecture 23 - Magneto Rheological Finishing and BE-MRF
- Lecture 24 - Magnetic Field Assisted Abrasive Finishing: CNP, CMMRF, MRAFF, R-MRAFF
- Lecture 25 - Summary of the Course

Lecture 1 - Basic of Solid Mechanics

Lecture 2 - Energy Principles

Lecture 3 - Classification of Plate Theories and Some Basics

Lecture 4 - Tutorial: Transformation of Tensors

Lecture 5 - Governing Equation for Plate - 1

Lecture 6 - Governing Equation for Plate - 2

Lecture 7 - Tutorial: Reduced Stiffness and Plate Stiffness

Lecture 8 - Navier Solution + Levy solution

Lecture 9 - Levy Solution

Lecture 10 - Tutorial: Load Matrices Calculation

Lecture 11 - EKM and buckling of plates

Lecture 12 - 3D Solutions

Lecture 13 - Matlab Coding + ABAQUS

Lecture 14 - Tutorial: Levy Solutions

Lecture 1 - Introduction to measurement

Lecture 2 - Generalized measurement system and static characteristics

Lecture 3 - Uncertainties in measurement

Lecture 4 - Statistical treatment of random errors

Lecture 5 - System response to periodic inputs

Lecture 6 - Zeroth and first order systems

Lecture 7 - First and second order systems

Lecture 8 - Basics of digitization and number systems

Lecture 9 - Binary logic gates and binary codes

Lecture 10 - Analog-to-digital conversion

Lecture 11 - Digital-to-analog conversion

Lecture 12 - Electromagnetic indicators

Lecture 13 - Electronic amplifiers and filters

Lecture 14 - Resistive devices

Lecture 15 - Inductive, capacitive and optical devices

Lecture 16 - Piezoelectric and nozzle-flapper transducers

Lecture 17 - Resistive strain gages and associated circuitry

Lecture 18 - Strain gage rosettes and gage orientation

Lecture 19 - Elastic and strain gage load cells

Lecture 20 - Various load cells and dynamometers

Lecture 21 - Principles of manometry

Lecture 22 - Piezometer and elastic pressure transducer

Lecture 23 - Electric pressure transducer and high and low pressure measurement

Lecture 24 - Bernoulli's equation in obstruction meters

Lecture 25 - Obstruction meters and volume flowmeters

Lecture 26 - Mass flowmeters and velocity probes

Lecture 27 - Expansion-based devices

Lecture 28 - RTD, Thermistor and Thermocouple

Lecture 29 - Introduction to pyrometers

Lecture 30 - Basic seismic transducer

Lecture 31 - Vibro-, velo- and accelerometer



[Lecture 32 - Introduction to acoustic measurement](#)

[Lecture 33 - Radioactivity and its biological effects](#)

Lecture 1 - External and Internal combustion engines, Engine components, SI and CI engines

Lecture 2 - Four-stroke and Two-stroke engines, Comparison between SI and CI engines, and Four-stroke and Two-stroke engines

Lecture 3 - Classification of IC engines

Lecture 4 - Engine operating characteristics

Lecture 5 - Otto, Diesel and Dual cycles

Lecture 6 - Otto, Diesel and Dual cycles (Continued...)

Lecture 7 - Otto, Diesel and Dual cycles (Continued...)

Lecture 8 - Otto, Diesel and Dual cycles (Continued...)

Lecture 9 - Comparison between the cycles, Actual cycles and their analysis

Lecture 10 - Carburetor, Mixture requirements

Lecture 11 - Carburetor, Mixture requirements (Continued...)

Lecture 12 - Idling, cruising and power ranges

Lecture 13 - Idling, cruising and power ranges (Continued...)

Lecture 14 - Classification, types of nozzles, Ignition system, Battery and Magneto ignition systems

Lecture 15 - Classification, types of nozzles, Ignition system, Battery and Magneto ignition systems (Continued...)

Lecture 16 - Classification, types of nozzles, Ignition system, Battery and Magneto ignition systems (Continued...)

Lecture 17 - Engine friction, Lubrication systems, forces on piston

Lecture 18 - Lubricating oils, Thermochemistry and Fuels, Self-ignition

Lecture 19 - Octane and Cetane Numbers, Alternative Fuels - Methanol, Ethanol, hydrogen, Natural Gas

Lecture 20 - Octane and Cetane Numbers, Alternative Fuels - Methanol, Ethanol, hydrogen, Natural Gas (Continued...)

Lecture 21 - Combustion in SI and CI Engines, Pressure Crank Angle Diagram

Lecture 22 - Combustion in SI and CI Engines, Pressure Crank Angle Diagram (Continued...)

Lecture 23 - Combustion in SI and CI Engines, Pressure Crank Angle Diagram (Continued...)

Lecture 24 - SI engine injection system, Energy distribution, Engine temperatures, Heat transfer in combustion chambers

Lecture 25 - SI engine injection system, Energy distribution, Engine temperatures, Heat transfer in combustion chambers (Continued...)

Lecture 26 - CI engine injection systems, Air-cooled and liquid-cooled engines, Modern trends

Lecture 27 - CI engine injection systems, Air-cooled and liquid-cooled engines, Modern trends (Continued...)

Lecture 28 - CI engine injection systems, Air-cooled and liquid-cooled engines, Modern trends (Continued...)

Lecture 29 - Problems on IC engine

Lecture 30 - Turbomachines, Gas Turbine theory

Lecture 31 - Open Cycle Gas Turbine Power Plant, Twin Shaft Arrangement

- Lecture 32 - Closed Cycle, Multi-Spool Arrangement, Steam Power Plant
- Lecture 33 - Basic Thermodynamics
- Lecture 34 - Brayton Cycle: Introduction and General Relationships
- Lecture 35 - Brayton Cycle: Efficiency, Work Ratio and Optimum Work Output Condition
- Lecture 36 - Brayton Cycle with Heat Exchanger/Reheater
- Lecture 37 - Brayton Cycle with Intercooler
- Lecture 38 - Real Brayton Cycle, Solved Example for Ideal Cycle
- Lecture 39 - Solved Examples for Real Brayton Cycle
- Lecture 40 - Introduction and Performance Parameters of Propulsion System
- Lecture 41 - Basics of Various Aircraft Engine
- Lecture 42 - Euler Turbomachinery Equation
- Lecture 43 - Introduction and Flow Analysis of Centrifugal Compressors
- Lecture 44 - Thermodynamics Analysis of Centrifugal Compressors
- Lecture 45 - Axial Compressor: Basics, Velocity triangles, T-S diagram and Work Interaction
- Lecture 46 - Axial Compressor: Different factors, Degree of Reaction and Free Vortex Condition
- Lecture 47 - Complete Analysis of Axial Flow Gas Turbine
- Lecture 48 - Solved Examples for Axial Compressors, Centrifugal Compressors and Turbine
- Lecture 49 - Radial Flow Turbine, Solved Example of Free vortex Condition
- Lecture 50 - Nozzles and Diffusers: Introduction, Intake efficiency, Nozzle efficiency

Lecture 1 - Introduction of welding

Lecture 2 - Classification of welding and joints

Lecture 3 - Parts of weld joint

Lecture 4 - Welding Symbol

Lecture 5 - welding power source - 1

Lecture 6 - Welding power source - 2

Lecture 7 - Welding Power sources characteristics - 1

Lecture 8 - Welding Power sources characteristics - 2

Lecture 9 - Physics of welding - 1

Lecture 10 - Physics of welding - 2

Lecture 11 - Physics of welding - 4 (Arc Stability and Arc Blow)

Lecture 12 - Physics of welding - 3

Lecture 13 - Physics of welding - 5 (Metal Transfer-1)

Lecture 14 - Physics of welding - 6 (Metal Transfer-2)

Lecture 15 - Physics of welding - 7 (Metal Transfer-3)

Lecture 16 - Physics of welding - 8 (Metal Transfer-4)

Lecture 17 - Physics of welding - 9 (Metal Transfer-5)

Lecture 18 - Physics of welding - 10 (Metalting Efficiency)

Lecture 19 - Oxy-Fuel Gas Welding

Lecture 20 - Shielded Metal Arc Welding

Lecture 21 - Gas Tungsten Arc Welding

Lecture 22 - Gas Metal Arc Welding

Lecture 23 - Submerged Arc Welding

Lecture 24 - Welding Defects and Inspection

Lecture 1 - Introduction to Polymer Assisted Abrasive Finishing Processes

Lecture 2 - Surface Integrity and Surface roughness representation - Part I

Lecture 3 - Surface Integrity and Surface roughness representation - Part II

Lecture 4 - Introduction to Grinding and Polymer assisted Grinding Wheels

Lecture 5 - Polymer medium for vibratory bowl finishing, Tumbling, Drag finishing

Lecture 6 - Polymer Pad and Chemo-mechanical Polishing

Lecture 7 - Elastic Emission Machining

Lecture 8 - Hydrodynamic Polishing, Elasto Abrasive Finishing

Lecture 9 - Abrasive Flow Machining and Finishing - Part I

Lecture 10 - Abrasive Flow Machining and Finishing - Part II

Lecture 11 - Advances in Abrasive Flow Finishing: DBGAFF, CFAAFM

Lecture 12 - Advances in Abrasive Flow Finishing: Spiral Polishing, R-AFF

Lecture 13 - AFF Processes: Magnetio AFF (MRAFF), UAA-AFF, EC-AFF

Lecture 14 - Finishing of Biomedical implants (Micro AFF: Micro holes, Micro slots, Bio Implants: Knee implants , Hip implants and Applications of one way, two way and orbital AFF)

Lecture 15 - Summary of the Course

- Lecture 1 - Materials and manufacturing Processes - 1
- Lecture 2 - Materials and manufacturing Processes - 2
- Lecture 3 - Physics based modeling approach at different scale
- Lecture 4 - Evaluation of properties and process modelling
- Lecture 5 - Thermofluid and electromagnetic analysis
- Lecture 6 - Solid-state deformation and residual stress - 1
- Lecture 7 - Solid-state deformation and residual stress - 2
- Lecture 8 - Melting, solidification and additive manufacturing
- Lecture 9 - Force and velocity diagram - 1
- Lecture 10 - Force and velocity diagram - 2
- Lecture 11 - Heat transfer analysis
- Lecture 12 - Principal and mechanism at different processes - 1
- Lecture 13 - Principal and mechanism at different processes - 2
- Lecture 14 - Mechanics of bulk metal forming
- Lecture 15 - Mechanics of sheet metal forming - 1
- Lecture 16 - Mechanics of sheet metal forming - 2
- Lecture 17 - Heat transfer and thermomechanical processing
- Lecture 18 - Fusion welding processes - 1
- Lecture 19 - Fusion welding processes - 2
- Lecture 20 - Physics of welding and metal transfer
- Lecture 21 - Heat source model in fusion welding
- Lecture 22 - Heat transfer and material flow
- Lecture 23 - Solidification in welding - 1
- Lecture 24 - Solidification in welding - 2
- Lecture 25 - Solid state welding - 1
- Lecture 26 - Solid state welding - 2
- Lecture 27 - Hybrid welding, residual stress and distortion
- Lecture 28 - Cooling and solidification at different casting processes
- Lecture 29 - Powder metallurgy
- Lecture 30 - Principle of surface and coating technologies
- Lecture 31 - Principle and development of additive manufacturing technologies - 1

[Lecture 32 - Principle and development of additive manufacturing technologies - 2](#)

[Lecture 33 - Fundamentals of heat treatment](#)

[Lecture 34 - Evaluation of microstructural properties and residual stress](#)

[Lecture 35 - Down-scaling of conventional manufacturing processes and Micro-to-nano manufacturing](#)

[Lecture 36 - Packaging, micro-finishing and micro-manufacturing processes](#)

[Lecture 37 - Processing and shaping of non-metals and bio-materials](#)

[Lecture 38 - Principle of glass and ceramics processing and their shaping](#)

[Lecture 1 - Introduction and Notation](#)

[Lecture 2 - Flow Regimes and Flow Regime Maps](#)

[Lecture 3 - The Homogeneous Model](#)

[Lecture 4 - The Separated Flow Model](#)

[Lecture 5 - The Separated Flow Model \(Continued...\)](#)

[Lecture 6 - The Drift Flux Model](#)

[Lecture 7 - Estimation of pressure drop in two phase flow](#)

[Lecture 8 - Two phase flow and pressure drop in miniature channels](#)



- Lecture 1 - Overview of thermodynamic system and state
- Lecture 2 - First and second laws of thermodynamics
- Lecture 3 - Concept of entropy and entropy generation
- Lecture 4 - Concept of exergy and exergy destruction
- Lecture 5 - Thermodynamic potentials and Maxwell relations
- Lecture 6 - Generalized relations for entropy and specific heats
- Lecture 7 - Joule-Thomson coefficient and Clapeyron equation
- Lecture 8 - Liquid-vapor phase-change process
- Lecture 9 - Use of property tables
- Lecture 10 - Equations-of-state and Compressibility factor
- Lecture 11 - Ideal cycles for reciprocating engines
- Lecture 12 - Otto, Diesel and Dual combustion cycles
- Lecture 13 - Stirling and Ericsson cycles
- Lecture 14 - Fuel-air cycle
- Lecture 15 - Numerical exercise on Fuel-air cycles
- Lecture 16 - Losses in actual cycle and valve-timing diagram
- Lecture 17 - Ideal Brayton cycle
- Lecture 18 - Intercooling and reheating in Brayton cycle
- Lecture 19 - Regeneration in Brayton cycle
- Lecture 20 - Ideal Rankine cycle
- Lecture 21 - Improvements and modifications in Rankine cycle
- Lecture 22 - Regenerative Rankine cycle
- Lecture 23 - Binary vapor power cycle
- Lecture 24 - Combined gas-steam power plant
- Lecture 25 - Different arrangements in combined cycles
- Lecture 26 - Vapor compression refrigeration cycle
- Lecture 27 - SSS cycles and refrigerants
- Lecture 28 - Modifications in VCR systems
- Lecture 29 - Vapor absorption refrigeration cycle
- Lecture 30 - P-v-T behavior of gas mixtures
- Lecture 31 - Numerical examples

[Lecture 32 - Properties of moist air](#)

[Lecture 33 - Psychrometric chart and various psychrometric processes](#)

[Lecture 34 - Sensible heat factor and bypass factor](#)

[Lecture 35 - Theoretical and actual combustion process](#)

[Lecture 36 - Thermodynamic analyses of reacting systems](#)

Lecture 1 - Relationship of Thermodynamics with Heat transfer

Lecture 2 - Modes of heat transfer

Lecture 3 - Fourier's law and thermal conductivity

Lecture 4 - Generalized heat diffusion equation

Lecture 5 - Heat diffusion equation in curvilinear coordinates

Lecture 6 - Concept of thermal resistance

Lecture 7 - Use of network of resistances in wall and cylinder

Lecture 8 - Critical thickness of insulation

Lecture 9 - Conduction with energy generation - I

Lecture 10 - Conduction with energy generation - II

Lecture 11 - General Heat Transfer Analysis

Lecture 12 - Fins with uniform cross-section area - I

Lecture 13 - Fins with uniform cross-section area - II

Lecture 14 - Fins with non-uniform cross-section area

Lecture 15 - Method of Separation of Variables

Lecture 16 - Graphical approach

Lecture 17 - Method of Superposition

Lecture 18 - Lumped capacitance approach - I

Lecture 19 - Lumped capacitance approach - II

Lecture 20 - Semi-infinite Solid

Lecture 21 - Steady Heat Conduction

Lecture 22 - Unsteady Heat Conduction

Lecture 23 - Problem solving using Energy Balance Method

Lecture 24 - Introduction to radiative heat fluxes

Lecture 25 - Spectral and directional definitions

Lecture 26 - Blackbody radiation

Lecture 27 - Emissivity

Lecture 28 - Irradiation of real surfaces

Lecture 29 - View factor

Lecture 30 - Blackbody radiation exchange

Lecture 31 - Radiation networks

[Lecture 32 - Gas radiation](#)

[Lecture 33 - Radiative Transfer Equation](#)

- Lecture 1 - Review of thermodynamics
- Lecture 2 - Rankine cycle
- Lecture 3 - Performance estimation of steam power cycles
- Lecture 4 - Carnot cycle examples
- Lecture 5 - Rankine cycle with superheat
- Lecture 6 - Rankine cycle with reheat theory and example
- Lecture 7 - Examples of Rankine cycle
- Lecture 8 - Examples of reheat Rankine cycle
- Lecture 9 - Rankine cycle with regeneration
- Lecture 10 - Feedwater heaters
- Lecture 11 - Cogeneration of power and process heat
- Lecture 12 - Examples of regeneration
- Lecture 13 - Examples of regenerative Rankine cycle
- Lecture 14 - Binary/multi-fluid cycles
- Lecture 15 - Low temperature power cycles
- Lecture 16 - Examples of binary cycles
- Lecture 17 - Types of boilers
- Lecture 18 - Boiler accessories
- Lecture 19 - Practice examples
- Lecture 20 - Stagnation conditions and Nozzle flow
- Lecture 21 - Nozzle flow
- Lecture 22 - Examples of Nozzle
- Lecture 23 - Impulse Turbine - 1
- Lecture 24 - Impulse Turbine - 2
- Lecture 25 - Examples on Impulse Turbine
- Lecture 26 - Reaction Turbine
- Lecture 27 - Reheat Factor
- Lecture 28 - Examples on Turbine - 1
- Lecture 29 - Examples on Turbine - 2
- Lecture 30 - Gas Mixture
- Lecture 31 - Psychrometry - 1

[Lecture 32 - Psychrometry - 2](#)

[Lecture 33 - Condensers](#)

- Lecture 1 - Introduction to Dynamic Behaviour of Materials - I
- Lecture 2 - Introduction to Dynamic Behaviour of Materials - II
- Lecture 3 - Introduction to Waves
- Lecture 4 - Quasi-static vs Dynamic Deformation
- Lecture 5 - Elastic Wave and its Classification
- Lecture 6 - Propagation of Elastic Waves in Continuum
- Lecture 7 - Wave Reflection, Refraction and Interaction
- Lecture 8 - General Solution of Elastic Wave Equation
- Lecture 9 - Additional Considerations of Elastic Wave in Cylindrical Bar
- Lecture 10 - Introduction to Plastic Waves
- Lecture 11 - Plastic Waves of Uniaxial Stress
- Lecture 12 - Plastic Waves of Combined Stress
- Lecture 13 - Taylor's Experiment for Plastic Wave Propagation - 1
- Lecture 14 - Taylor's Experiment for Plastic Wave Propagation - 2
- Lecture 15 - Taylor's Experiment: Wilkins-Guinan Analysis
- Lecture 16 - Introduction to Shock Waves - I
- Lecture 17 - Introduction to Shock Waves - II
- Lecture 18 - Shock Wave: Rankine Hugoniot Treatment
- Lecture 19 - Rankine Hugoniot Treatment and Shock Wave under Impact
- Lecture 20 - Shock Wave under Impact
- Lecture 21 - Equations of States (Shock Waves) : Experimental Methods
- Lecture 22 - Equations of States (Shock Waves) : Theoretical Calculations
- Lecture 23 - Complex Problems of Shock Waves and Temperature Rise under Shock Wave
- Lecture 24 - Shock Wave Attenuation, Interaction and Reflection - I
- Lecture 25 - Shock Wave Attenuation, Interaction and Reflection - II
- Lecture 26 - Shock Wave Interaction and Reflection
- Lecture 27 - Fundamentals of Materials Science and Engineering
- Lecture 28 - Shock Wave Induced Phase Transformations - 1
- Lecture 29 - Shock Wave Induced Phase Transformations - 2
- Lecture 30 - Shock Wave Induced Phase Transformations - 3
- Lecture 31 - Shock Wave Induced Phase Transformations - 4

[Lecture 32 - Experimental Techniques for Dynamic Deformation - 1](#)

[Lecture 33 - Experimental Techniques for Dynamic Deformation - 2](#)

[Lecture 34 - Plastic Deformation at High Strain Rates - 1](#)

[Lecture 35 - Plastic Deformation at High Strain Rates - 2](#)

[Lecture 36 - Plastic Deformation at High Strain Rates - 3](#)

[Lecture 37 - Plastic Deformation at High Strain Rates - 4](#)

[Lecture 38 - Plastic Deformation at High Strain Rates - 5](#)

[Lecture 39 - Plastic Deformation Under Shock Waves - 1](#)

[Lecture 40 - Plastic Deformation Under Shock Waves - 2](#)

[Lecture 41 - Plastic Deformation Under Shock Waves - 3](#)

[Lecture 42 - Shear Band - 1](#)

[Lecture 43 - Shear Band - 2](#)

[Lecture 44 - Dynamic Fracture - 1](#)

[Lecture 45 - Dynamic Fracture - 2](#)



Lecture 1 - Introduction to Plastic Working of Metals

Lecture 2 - Uniaxial Tension Test Analysis

Lecture 3 - Temperature effects in metal forming

Lecture 4 - Friction and Lubrication

Lecture 5 - Friction and Lubrication (Continued...)

Lecture 6 - Deformation zone + worked examples

Lecture 7 - Stresses at point and Theory of Plasticity

Lecture 8 - Slab Analysis

Lecture 9 - Slip Line Field Theory - Part 1

Lecture 10 - Slip Line Field Theory - Part 2

Lecture 11 - Upper Bound Theorem

Lecture 12 - Plasticity equations

Lecture 13 - Forging

Lecture 14 - Analysis of Forging

Lecture 15 - Analysis of Forging (Continued...)

Lecture 16 - Forging Die Design consideration

Lecture 17 - Forging Load

Lecture 18 - Rolling of Metals

Lecture 19 - Analysis of Rolling

Lecture 20 - Analysis of Rolling (Continued...)

Lecture 21 - Strain rate in the deformation zone

Lecture 22 - Rolling mills

Lecture 23 - Problem on rolling

Lecture 24 - Drawing of Rods, Wires and Tubes

Lecture 25 - Drawing of Rods, Wires and Tubes (Continued...)

Lecture 26 - Analysis of Wire Drawing

Lecture 27 - Wire Drawing: Tutorial Problems

Lecture 28 - Extrusion Process

Lecture 29 - Analysis of Extrusion

Lecture 30 - Introduction

Lecture 31 - Sheet deformation process

[Lecture 32 - Deformation of sheet in plane stress](#)

[Lecture 33 - Analysis of stamping](#)

[Lecture 34 - Instability in sheet metal forming](#)

[Lecture 35 - Deep drawing](#)

[Lecture 36 - Hydroforming](#)

- Lecture 1 - Introduction to Artificial Intelligence
- Lecture 2 - Problem Solving as State Space Search
- Lecture 3 - Uninformed Search
- Lecture 4 - Heuristic Search
- Lecture 5 - Informed Search
- Lecture 6 - Constraint Satisfaction Problems
- Lecture 7 - Searching AND/OR Graphs
- Lecture 8 - Game Playing
- Lecture 9 - Minimax + Alpha-Beta
- Lecture 10 - Introduction to Knowledge Representation
- Lecture 11 - Propositional Logic
- Lecture 12 - First Order Logic - I
- Lecture 13 - First Order Logic - II
- Lecture 14 - Inference in First Order Logic - I
- Lecture 15 - Inference in First Order Logic - II
- Lecture 16 - Answer Extraction
- Lecture 17 - Procedural Control of Reasoning
- Lecture 18 - Reasoning under Uncertainty
- Lecture 19 - Bayesian Network
- Lecture 20 - Decision Network
- Lecture 21 - Introduction to Planning
- Lecture 22 - Plan Space Planning
- Lecture 23 - Planning Graph and GraphPlan
- Lecture 24 - Practical Planning and Acting
- Lecture 25 - Sequential Decision Problems
- Lecture 26 - Making Complex Decisions
- Lecture 27 - Introduction to Machine Learning
- Lecture 28 - Learning Decision Trees
- Lecture 29 - Linear Regression
- Lecture 30 - Support Vector Machines
- Lecture 31 - Unsupervised Learning

[Lecture 32 - Reinforcement Learning](#)

[Lecture 33 - Learning in Neural Networks](#)

[Lecture 34 - Deep Learning: A Brief Overview](#)

Lecture 1 - Overview of Basic Thermodynamics

Lecture 2 - Solved Examples for Flow process

Lecture 3 - Turbomachines: Introduction, Classification, Types

Lecture 4 - Components of Gas Turbine Power Plant, Gas Turbine Attachments

Lecture 5 - Introduction to Various Aircraft engines, Engine Performance parameters

Lecture 6 - Air Standard Ideal Brayton Cycle

Lecture 7 - Examples for Ideal Brayton Cycle

Lecture 8 - Non-Ideal Brayton Cycle

Lecture 9 - Examples for Non-Ideal Brayton Cycle

Lecture 10 - Brayton Cycle with Heat Exchanger / Re-heater

Lecture 11 - Brayton Cycle with Intercooler / All Attachments

Lecture 12 - Examples of Gas Turbine Attachment

Lecture 13 - Examples of Gas Turbine Attachment

Lecture 14 - Stagnation Conditions, Real Brayton Cycle with Stagnation Conditions

Lecture 15 - Polytropic Efficiency of Compressor and Turbine

Lecture 16 - Examples of Real Cycle

Lecture 17 - Nozzle Flow: Isentropic Relations, Area Velocity Relation, Choked Mass Flow Rate

Lecture 18 - Aircraft Engine Intake, Intake Efficiency

Lecture 19 - Propelling Nozzle, Nozzle Efficiency

Lecture 20 - Turbojet engine: Configuration and Examples

Lecture 21 - Turbofan engine: Configuration and Examples

Lecture 22 - Ramjet engine: Parameters and losses

Lecture 23 - Examples of Ramjet Engine

Lecture 24 - Thrust Augmentation and Engine performance parameters for Aircrafts

Lecture 25 - Introduction to Turbomachinery

Lecture 26 - Centrifugal Compressor: Velocity diagrams, Workdone

Lecture 27 - Centrifugal Compressor: Thermodynamic analysis, Stage efficiency and Degree of reaction

Lecture 28 - Examples of Centrifugal compressor

Lecture 29 - Axial Flow Compressor: Velocity diagrams, Workdone and Degree of Reaction

Lecture 30 - Axial Flow Compressor: Free vortex Condition

Lecture 31 - Examples of Axial Flow Compressor

[Lecture 32 - Examples of Axial Flow Compressor](#)

[Lecture 33 - Examples of Axial Flow Compressor](#)

[Lecture 34 - Axial Turbine: Velocity diagrams, Workdone, and Degree of Reaction](#)

[Lecture 35 - Radial Turbine: Velocity diagrams, h-s diagram, Stage efficiency and degree of reaction](#)

[Lecture 36 - Examples of Axial Turbine](#)

[Lecture 37 - Practice examples of Axial Turbine and centrifugal compressor](#)

[Lecture 38 - Cascade theory and Blade design](#)

[Lecture 39 - Cascade variables and Turbine Cascade](#)

[Lecture 40 - Velocity diagrams of Turbine Cascade, Compressor cascade](#)

[Lecture 41 - Turbine cooling methods](#)

[Lecture 42 - Practice examples of aircraft engine](#)

Lecture 1 - Applications of CFD

Lecture 2 - Basic equations of fluid dynamics and heat transfer

Lecture 3 - Initial and boundary conditions

Lecture 4 - Physical Classification, System of first-order PDEs

Lecture 5 - System of second-order PDEs

Lecture 6 - Finite difference by Taylor series expansion

Lecture 7 - Finite difference by general approximation and polynomials

Lecture 8 - Finite difference in non-uniform grid

Lecture 9 - Types of error and accuracy of FD solutions

Lecture 10 - Finite difference formulations of Elliptic Equations with boundary condition treatment

Lecture 11 - Iterative Methods

Lecture 12 - Applications

Lecture 13 - Linear Solvers

Lecture 14 - Finite difference formulations of Parabolic Equations

Lecture 15 - Finite difference formulations of Parabolic Equations: Implicit Methods

Lecture 16 - Finite difference formulations of Parabolic Equations: Unsteady Two-Dimensional Equation

Lecture 17 - Finite difference formulations of Parabolic Equations: Unsteady Three-Dimensional Equation

Lecture 18 - Finite difference formulations of the first order wave equation: Explicit Method

Lecture 19 - Finite difference formulations of the first order wave equation: Implicit Method

Lecture 20 - Von Neumann stability analysis of different schemes for Parabolic equations

Lecture 21 - Von Neumann stability analysis of different schemes for Parabolic equations

Lecture 22 - Von Neumann stability analysis of different schemes for Hyperbolic equations

Lecture 23 - Modified equation, Artificial viscosity, Numerical diffusion

Lecture 24 - Discretization vorticity-stream function equations using FDM

Lecture 25 - Boundary conditions for flow problems

Lecture 26 - Solutions of vorticity-stream function equations

Lecture 27 - Solution of Navier-Stokes Equation using FDM

Lecture 28 - Solution of Navier-Stokes Equation using FDM (Continued...)

Lecture 29 - Introduction to finite volume method

Lecture 30 - Finite volume discretization of steady diffusion equation

Lecture 31 - Finite volume discretization of unsteady diffusion equation

[Lecture 32 - Finite volume discretization of steady convection-diffusion equation](#)

[Lecture 33 - Finite volume discretization of unsteady convection-diffusion equation](#)

[Lecture 34 - Convection Schemes](#)

[Lecture 35 - Solution of Navier-Stokes Equations using FVM - I](#)

[Lecture 36 - Solution of Navier-Stokes Equations using FVM - II](#)

[Lecture 37 - Boundary Conditions](#)



Lecture 1 - Basic concepts, Calibration

Lecture 2 - Dimensions, Units, Standards, Systems of dimensions, System of units, Unit conversion table

Lecture 3 - Basic concept of dynamic measurements

Lecture 4 - Basic concept of dynamic measurements (Continued...)

Lecture 5 - Basic concept of dynamic measurements (Continued...)

Lecture 6 - System response and distortion, Impedance matching

Lecture 7 - Dimensional measurement Gauge blocks, The pneumatic displacement gauge

Lecture 8 - Dimensional measurement Gauge blocks, The pneumatic displacement gauge

Lecture 9 - Pressure Measurements: Definition of pressure and Dynamic response considerations

Lecture 10 - Mechanical pressure measurement devices, U-tube manometer, The inclined well type manometer

Lecture 11 - The aneroid barometer, Diaphragm and Bellows Gauges

Lecture 12 - The Mcleod gauge, The Pirani gauge, The Ionization gauge

Lecture 13 - The Mcleod gauge, The Pirani gauge, The Ionization gauge (Continued...)

Lecture 14 - The Mcleod gauge, The Pirani gauge, The Ionization gauge (Continued...)

Lecture 15 - Pressure measurement using 3 holes/probes

Lecture 16 - Pressure measurement using 3 holes/probes (Continued...)

Lecture 17 - Flow obstruction flow rate measurement(venturimeter/orificemeter), the Rotameter

Lecture 18 - Flow obstruction flow rate measurement(venturimeter/orificemeter), the Rotameter (Continued...)

Lecture 19 - Thermal Anemometry(hot wire/hot film), Hot wire anemometer

Lecture 20 - Thermal Anemometry(hot wire/hot film), Hot wire anemometer (Continued...)

Lecture 21 - Laser Doppler anemometry

Lecture 22 - Measurement of velocity components by 3 holes and 4 holes probes

Lecture 23 - Ideal gas thermometer, Temperature measurement by mechanical and electrical effects

Lecture 24 - Ideal gas thermometer, Temperature measurement by mechanical and electrical effects (Continued...)

Lecture 25 - Thermostatic temperature, Resistance Temperature Detectors (RTD), Thermistors, Thermocouples

Lecture 26 - Temperature measurement by Radiation, The optical pyrometer

Lecture 27 - Transient response of thermal system, Thermocouple compensation, high speed flow

Lecture 28 - Transient response of thermal system, Thermocouple compensation, high speed flow (Continued...)

Lecture 29 - Transient response of thermal system, Thermocouple compensation, high speed flow (Continued...)

Lecture 30 - Constant temperature hot-wire anemometer, LDA

Lecture 31 - Use of PIV

[Lecture 32 - Use of PIV \(Continued...\)](#)

[Lecture 33 - Use of PIV \(Continued...\)](#)

[Lecture 34 - Measurement of pitch angle](#)

[Lecture 35 - Measurement of torque by dynamometers, strain gauge, transducers](#)

[Lecture 36 - Measurement of microscale flow features - I](#)

[Lecture 37 - Measurement of microscale flow features - II](#)

[Lecture 38 - Transient and Frequency response consideration](#)

[Lecture 39 - Examples](#)

[Lecture 40 - Analysis of experimental data, causes and types of experimental errors](#)

[Lecture 41 - Rejection of data: Chauvenets Criterion with example](#)

[Lecture 42 - Error propagation: function of two variables, several variables](#)

[Lecture 43 - The Method of Least square with example](#)

Lecture 1 - Basic concepts

Lecture 2 - Mechatronics

Lecture 3 - Mechatronics based systems

Lecture 4 - Automated systems and equipment used in manufacturing - Part I

Lecture 5 - Automated systems and equipment used in manufacturing - Part II

Lecture 6 - Selection of electrical and electronics components for mechatronics based systems

Lecture 7 - Terms related to performance of electro-mechanical systems

Lecture 8 - Computer aided design of components

Lecture 9 - Fabrication Processes

Lecture 10 - Measurement system and potentiometer sensors

Lecture 11 - Displacement, position and proximity sensors - I

Lecture 12 - Displacement, position and proximity sensors - II

Lecture 13 - Fluid flow, pressure, and temperature measurement

Lecture 14 - Signal Conditioning: amplification, filtering

Lecture 15 - Pulse modulation, Protection devices, and Wheatstone bridge

Lecture 16 - Signal conversion

Lecture 17 - Microprocessor Technology

Lecture 18 - Introduction to Microprocessor Programming

Lecture 19 - Application of electric drives in automation

Lecture 20 - DC and AC motors

Lecture 21 - Stepper motor and servo motor

Lecture 22 - Types of industrial automation and mechanisms

Lecture 23 - Ball screw based linear motion drives

Lecture 24 - Application of cams in automation

Lecture 25 - Application of indexing mechanisms in automation

Lecture 26 - Application of tool magazines in automation

Lecture 27 - Material handling systems

Lecture 28 - Fundamental concepts

Lecture 29 - Hydraulic pumps

Lecture 30 - Direction control valves

Lecture 31 - Flow control and pressure relief valves

[Lecture 32 - Graphical representation of hydraulic system elements](#)

[Lecture 33 - Basic concepts and air compressors](#)

[Lecture 34 - Air treatment and pressure regulation](#)

[Lecture 35 - Graphical representation and pneumatic circuits](#)

[Lecture 36 - Computer aided manufacturing and process planning](#)

[Lecture 37 - CNC machines and interpolation](#)

[Lecture 38 - CNC Programming](#)

Lecture 1 - Review Concepts of Fluid Mechanics and Thermodynamics - I

Lecture 2 - Review Concepts of Fluid Mechanics and Thermodynamics - II

Lecture 3 - Review Concepts of Fluid Mechanics and Thermodynamics - III

Lecture 4 - Wave Propagation in Compressible Medium - I

Lecture 5 - Wave Propagation in Compressible Medium - II

Lecture 6 - Wave Propagation in Compressible Medium - III

Lecture 7 - Quasi-One Dimensional Isentropic Flow - I

Lecture 8 - Quasi-One Dimensional Isentropic Flow - II

Lecture 9 - Quasi-One Dimensional Isentropic Flow - III

Lecture 10 - Normal Shock Waves - I

Lecture 11 - Normal Shock Waves - II

Lecture 12 - Normal Shock Waves - III

Lecture 13 - Normal Shock Waves - IV

Lecture 14 - Expansion Waves and Oblique Shocks - I

Lecture 15 - Expansion Waves and Oblique Shocks - II

Lecture 16 - Expansion Waves and Oblique Shocks - III

Lecture 17 - Expansion Waves and Oblique Shocks - IV

Lecture 18 - Expansion Waves and Oblique Shocks - V

Lecture 19 - Expansion Waves and Oblique Shocks - VI

Lecture 20 - Supersonic Nozzles and Diffusers - I

Lecture 21 - Supersonic Nozzles and Diffusers - II

Lecture 22 - Supersonic Nozzles and Diffusers - III

Lecture 23 - Measurement Diagnostics and Experimental Facilities for Compressible Flow - II

Lecture 24 - Compressible Flow with Friction and Heat Transfer - II

Lecture 25 - Compressible Flow with Friction and Heat Transfer - III

Lecture 26 - Measurement Diagnostics and Experimental Facilities for Compressible Flow - I

Lecture 27 - Measurement Diagnostics and Experimental Facilities for Compressible Flow - II

Lecture 28 - Measurement Diagnostics and Experimental Facilities for Compressible Flow - III

Lecture 29 - Measurement Diagnostics and Experimental Facilities for Compressible Flow - IV

Lecture 30 - Measurement Diagnostics and Experimental Facilities for Compressible Flow - V

Lecture 31 - Measurement Diagnostics and Experimental Facilities for Compressible Flow - VI



Lecture 1 - Functional, First variation, Euler Lagrange equation; Several Dependent variables

Lecture 2 - Functional with higher order derivatives; Variational statement

Lecture 3 - Differential equation, Variational statement and Minimization problem; Rayleigh-Ritz method

Lecture 4 - FEM steps: Explained with discrete linear springs; Gaussian Quadrature rule for integration

Lecture 5 - Solving one Ordinary Differential Equation using Linear Finite Element

Lecture 6 - Solving one Ordinary Differential Equation using Quadratic Finite Element

Lecture 7 - Bar Element: Elemental equation; Matlab Implementation with Example

Lecture 8 - Bar Element: Postprocessing; Comparison with Analytical Solution; Bar with linear springs

Lecture 9 - Truss Element: Elemental equation; Matlab Implementation with Example

Lecture 10 - Beam Element: Variational statement; Hermite shape function

Lecture 11 - Beam Element: Elemental equation; Matlab implementation with Example

Lecture 12 - Beam Element: Matlab implementation for the example with Non-uniform distributed load

Lecture 13 - Frame Element: Derivation of elemental equation in global reference frame

Lecture 14 - Frame Element: Matlab implementation with one Example

Lecture 15 - Generalization of Geometry data; Stiffness matrix, Load vector formation at element level

Lecture 16 - Generalization of Assembly, Imposition of Boundary condition and Load information

Lecture 17 - Indicjal Notation: Summation convention, Kronecker delta, Permutation symbol

Lecture 18 - Second order tensor; Gradient, Divergence, Curl and Laplacian in Indicjal notation

Lecture 19 - Gauss Divergence theorem and its application in Heat transfer and Structural analysis

Lecture 20 - Derivation of weak form of 2D steady-state heat conduction problem

Lecture 21 - Triangular element, calculating element stiffness and element force vector

Lecture 22 - Numerical example, assembly, mapping

Lecture 23 - Numerical integration, Neumann boundary, and higher order shape functions

Lecture 24 - Quadrilateral element, Lagrange shape functions, Serendipity elements

Lecture 25 - Development of a MATLAB code for solving 2D steady-state heat conduction problem

Lecture 26 - Demonstration of the MATLAB code

Lecture 27 - Elasticity problems in two dimension and obtaining the weak form

Lecture 28 - Deriving element stiffness matrix and element force vector, numerical example

Lecture 29 - Development of a MATLAB code for solving planar elasticity problems

Lecture 30 - Superconvergent Patch Recovery, error estimator, adaptive refinement

Lecture 31 - Solving eigenvalue problem in bar and beam, writing FEM code in MATLAB

[Lecture 32 - Solving eigenvalue problem of membrane, writing FEM code in MATLAB](#)

[Lecture 33 - Solving transient problems \(parabolic type\)](#)

[Lecture 34 - Solving transient problems \(hyperbolic type\)](#)

[Lecture 35 - Solving elasticity problems in 3D using FEM, Solvers](#)



Lecture 1 - Origin of nonlinearities - 1

Lecture 2 - Origin of nonlinearities - 2

Lecture 3 - Tensor and Tensor Algebra - 1

Lecture 4 - Tensor and Tensor Algebra - 2

Lecture 5 - Tensor and Tensor Algebra - 3

Lecture 6 - Tensor and Tensor Algebra - 4

Lecture 7 - Linearization and directional derivative, Tensor analysis - 1

Lecture 8 - Linearization and directional derivative, Tensor analysis - 2

Lecture 9 - Worked Examples - 1

Lecture 10 - Worked Examples - 2

Lecture 11 - Idea of Motion, Material and Spatial Descriptions, Deformation Gradient Tensor

Lecture 12 - Strain, Polar Decomposition - 1

Lecture 13 - Polar Decomposition - 2, Volume and Area Change

Lecture 14 - Worked Examples, Linearized Kinematics

Lecture 15 - Velocity, Acceleration, Material Time Derivative

Lecture 16 - Velocity Gradient, Rate of Deformation tensor, Area and Volume Rate, Reynolds Transport Theorem

Lecture 17 - Solved Examples

Lecture 18 - Conservation of Mass, Balance of Linear Momentum, Cauchy's Stress Principle - 1

Lecture 19 - Cauchy's Stress Principle - 2, Cauchy Stress Tensor

Lecture 20 - Objectivity, Stress Objectivity, Equilibrium Equations - 1

Lecture 21 - Equilibrium Equations - 2, Principle of Virtual Work

Lecture 22 - Work Conjugacy, First Piola-Kirchhoff Stress Tensor

Lecture 23 - Second Piola-Kirchhoff Stress Tensor, Decomposition of Stress - 1

Lecture 24 - Decomposition of Stress - 2, Objective Stress Measures

Lecture 25 - Solved Examples

Lecture 26 - Constitutive relations and constraints, Hyperelasticity, Material elasticity tensor

Lecture 27 - Spatial Elasticity Tensor, Solved Example

Lecture 28 - Isotropic hyperelasticity - material and spatial description, Hyperelastic models

Lecture 29 - Isotropic Hyperelasticity, Neo-Hookean Material Model, Solved Examples

Lecture 30 - Introduction, Linearization Process Overview

Lecture 31 - Linearization of Internal Virtual Work and External Virtual Work

[Lecture 32 - Discretization of Kinematic Quantities, Equilibrium Equations](#)

[Lecture 33 - Discretization of Linearized Equilibrium Equations](#)

[Lecture 34 - Newton Raphson Method](#)

[Lecture 35 - Line Search Method](#)

[Lecture 36 - Arc Length Method, Solved Examples](#)

[Lecture 37 - FE Formulation of Ductile Fracture in Dynamic Elasto-Plastic Contact Problem - Introduction](#)

[Lecture 38 - FE Formulation of Ductile Fracture in Dynamic Elasto-Plastic Contact Problem - Formulation](#)

[Lecture 39 - FE Formulation of Ductile Fracture in Dynamic Elasto-Plastic Contact Problem - FEM](#)

[Lecture 40 - FE Formulation of Ductile Fracture in Dynamic Elasto-Plastic Contact Problem - Results](#)

Lecture 1 - Application of convective heat transfer

Lecture 2 - Foundations of heat transfer

Lecture 3 - Derivation of energy equation

Lecture 4 - Derivation of boundary layer equation

Lecture 5 - Derivation of boundary layer energy equation

Lecture 6 - Blasius solution: similarity method

Lecture 7 - Pohlhausen solution: similarity method

Lecture 8 - Pohlhausen solution: heat transfer parameters

Lecture 9 - Falkner-Skan equation: Boundary layer flow over a wedge

Lecture 10 - Momentum integral equation for flat plate boundary layer

Lecture 11 - Laminar BL flow over flat plate: Uniform surface temperature

Lecture 12 - Laminar BL flow over flat plate: Uniform surface heat flux

Lecture 13 - Solution of example problems

Lecture 14 - Hydrodynamic and thermal regions

Lecture 15 - Energy balance in channel flow

Lecture 16 - Determination of heat transfer coefficient

Lecture 17 - Velocity profile in fully-developed channel flows

Lecture 18 - Thermally fully developed laminar slug flow with uniform wall heat flux condition

Lecture 19 - Hydrodynamically and thermally fully developed flow with uniform wall heat flux condition

Lecture 20 - Fully developed flow through parallel plate channel with uniform wall temperature

Lecture 21 - Fully developed flow through circular pipe with uniform wall temperature

Lecture 22 - Thermally developing flow through circular pipe with uniform wall heat flux

Lecture 23 - Thermally developing flow through circular pipe with uniform wall temperature

Lecture 24 - Heat transfer in plane Couette flow

Lecture 25 - Solutions of example problems

Lecture 26 - Introduction and scale analysis

Lecture 27 - Natural convection over a vertical plate: Similarity Solution

Lecture 28 - Natural convection over a vertical plate: Similarity solution of energy equation

Lecture 29 - Natural convection over a vertical plate: Integral solution

Lecture 30 - Natural convection over inclined plate and mixed convection

Lecture 31 - Natural convection inside enclosures

[Lecture 32 - Solution of example problems](#)

[Lecture 33 - Basics of finite difference method](#)

[Lecture 34 - Solution of Navier-Stokes equations](#)

[Lecture 35 - Solution of energy equation](#)

[Lecture 36 - Derivation of Reynolds Averaged Navier-Stokes Equations](#)

[Lecture 37 - External Turbulent Flow](#)

[Lecture 38 - Integral solution for turbulent boundary layer flow over a flat plate](#)

[Lecture 39 - Convection in turbulent pipe flow](#)

[Lecture 40 - Boiling regimes and boiling curve](#)

[Lecture 41 - Laminar film condensation on a vertical plate](#)

[Lecture 42 - Laminar film condensation on horizontal tube](#)

[Lecture 43 - Solution of example problems](#)

Lecture 1 - Introduction to composite materials

Lecture 2 - Basic terminology in Shell

Lecture 3 - Derivation of fundamental theorem of surfaces

Lecture 4 - Derivative of unit vectors and various theorems

Lecture 5 - Classification of shells

Lecture 6 - Derivation of strain-displacement relation

Lecture 7 - Derivation of shell governing equations - 1

Lecture 8 - Derivation of shell governing equations - 2

Lecture 9 - Derivation of shell governing equations - 3

Lecture 10 - Derivation of special cases

Lecture 11 - Derivation of shell constitutive relations

Lecture 12 - Solved examples on membrane theory and moment shell theory

Lecture 13 - Shell of revolution problems

Lecture 14 - Derivation of Navier solution for infinite shell panel

Lecture 15 - Basics of MATLAB coding

Lecture 16 - Derivation of Navier solution for finite shell panel

Lecture 17 - ABAQUS Modelling

Lecture 18 - Extended Kanatovich method for shell panel

Lecture 19 - Free Vibration solution of shell panels under Navier and Levy supports - 1

Lecture 20 - Free Vibration solution of shell panels under Navier and Levy supports - 2

Lecture 21 - Basics of Buckling of shells

Lecture 22 - Buckling of cylindrical shells

Lecture 23 - Buckling of Levy-type cylindrical shells

Lecture 24 - 3D Bending

Lecture 25 - 3D Free vibration

Lecture 26 - 3D Buckling

Lecture 27 - Advanced Material

Lecture 28 - Free vibration of a composite cylindrical shell

- Lecture 1 - Properties, Modelling approaches, Process modelling and Optimization
- Lecture 2 - Fusion welding - 1
- Lecture 3 - Fusion welding - 2
- Lecture 4 - Soldering, Brazing, Solid-state welding processes
- Lecture 5 - Advanced welding processes
- Lecture 6 - Advances in laser microwelding
- Lecture 7 - Additive manufacturing processes
- Lecture 8 - Elastic stress analysis - I
- Lecture 9 - Elastic stress analysis - II and Potential energy method
- Lecture 10 - Three-Dimensional element
- Lecture 11 - Weighted residual method
- Lecture 12 - Material nonlinearity - I
- Lecture 13 - Material nonlinearity - II
- Lecture 14 - Fluid flow and Natural coordinate system - I
- Lecture 15 - Natural coordinate system in 3D and XFEM
- Lecture 16 - Introduction to heat source model
- Lecture 17 - Heat source models in welding - I
- Lecture 18 - Heat source models in welding - II
- Lecture 19 - Heat source model for Keyhole mode and solid state welding
- Lecture 20 - Implementation of FEM in fusion welding processes
- Lecture 21 - Implementation of FEM for fluid flow in fusion welding processes
- Lecture 22 - FEM modeling of EBW and RSW
- Lecture 23 - FEM modeling of FSW and hybrid FSW
- Lecture 24 - Demonstration of thermal model development using commercial software
- Lecture 25 - Fluid flow modeling in welding processes
- Lecture 26 - Heat transfer and fluid flow analysis in quasi-steady state
- Lecture 27 - Prediction of free surface profile
- Lecture 28 - Principle stress, Hydrostatic and Deviatoric Components of Stress
- Lecture 29 - Yield Function, Von Mises Yield Surface and Hardening rule
- Lecture 30 - Material models, Residual stress and distortion
- Lecture 31 - Phase transformation effect on Residual stress and distortion

[Lecture 32 - Demonstration of thermo-mechanical model development using commercial software](#)

[Lecture 33 - Fundamentals of metal transfer in arc welding](#)

[Lecture 34 - FE-based modelling approaches](#)

[Lecture 35 - Theoretical development of heat transfer model](#)

[Lecture 36 - Heating of nano-film](#)

[Lecture 37 - Theoretical development of stress analysis model](#)

[Lecture 38 - Fundamentals of wire arc additive manufacturing processes - I](#)

[Lecture 39 - Fundamentals of wire arc additive manufacturing processes - II](#)

[Lecture 40 - Modelling approaches of additive manufacturing](#)

Lecture 1 - Introduction to mechanical systems

Lecture 2 - Superposition rule, Commonly used nonlinear equations

Lecture 3 - Equilibrium points: potential function

Lecture 4 - Force and moment based Approach, Lagrange Principle

Lecture 5 - Extended Hamilton's principle

Lecture 6 - Use of scaling and book-keeping parameter for ordering

Lecture 7 - Numerical solution, Analytical solutions: Harmonic Balance method

Lecture 8 - Straight forward expansion

Lecture 9 - Lindsted-Poincaré method

Lecture 10 - Method of Averaging

Lecture 11 - Method of multiple scales

Lecture 12 - Method of generalized Harmonic Balance method

Lecture 13 - Free vibration of undamped and damped SDOF systems with quadratic and cubic nonlinearity

Lecture 14 - Super and sub harmonic resonance conditions

Lecture 15 - Bifurcation analysis of fixed-point response

Lecture 16 - Nonlinear system with hard excitations

Lecture 17 - Super and sub harmonic resonance conditions

Lecture 18 - Bifurcation analysis of fixed-point response

Lecture 19 - Floquet theory, Hill's infinite determinant, Resonance in parametrically excited systems

Lecture 20 - Parametrically excited pneumatic artificial muscle

Lecture 21 - Parametric instability of sandwich plate

Lecture 22 - Analysis of periodic, quasi-periodic and chaotic systems

Lecture 23 - Stability and bifurcation analysis of periodic and quasi-periodic response

Lecture 24 - Analysis of chaotic system

Lecture 25 - Numerical methods for finding roots and solutions of ODE

Lecture 26 - Time response, phase portraits, frequency response

Lecture 27 - Poincaré section, FFT, Lyapunov exponent

Lecture 28 - Passive and active vibration absorber with displacement and acceleration feedback

Lecture 29 - Active vibration absorber with time delay acceleration feedback by HBM

Lecture 30 - Application of Active vibration absorber with combination feedback

Lecture 31 - Cantilever beam with tip mass for principal parametric resonance



[Lecture 32 - Cantilever beam with tip mass for combination resonance](#)

[Lecture 33 - Cantilever beam based piezoelectric based energy harvester](#)

[Lecture 34 - Nonlinear dynamics of turning operation with delay and internal resonance](#)

[Lecture 35 - Chatter in rolling mills and dynamic analysis of artificial pneumatic muscle](#)

[Lecture 36 - Chaotic systems and control of chaos](#)

Lecture 1 - Introduction to Optimization

Lecture 2 - Introduction to Evolutionary Computation

Lecture 3 - Binary-Coded Genetic Algorithm (BGA)

Lecture 4 - Operators and Simulations of Binary-Coded Genetic Algorithm

Lecture 5 - Real-Coded Genetic Algorithm (RGA)

Lecture 6 - Operators and Simulations of Real-Coded Genetic Algorithm

Lecture 7 - Algorithmic Implementation of BGA and RGA

Lecture 8 - Particle Swarm Optimization (PSO)

Lecture 9 - Simulations and Algorithmic Implementation of Particle Swarm Optimization

Lecture 10 - Differential Evolution (DE)

Lecture 11 - Simulations and Algorithmic Implementation of Differential Evolution

Lecture 12 - Constrained Optimization: Introduction and Optimality

Lecture 13 - Penalty Function Methods for Evolutionary Computing Techniques

Lecture 14 - Evolutionary Computing Techniques: Separation of Objective Function and Constraints

Lecture 15 - Simulations of Constraint Handling Techniques - Part 1

Lecture 16 - Simulations of Constraint Handling Techniques - Part 2

Lecture 17 - Introduction to Multi-Objective Optimization - Part 1

Lecture 18 - Introduction to Multi-Objective Optimization - Part 2

Lecture 19 - Multi-Objective Optimization: Ranking and Diversity

Lecture 20 - Classical Multi-Objective Optimization Methods

Lecture 21 - Non-Dominated Genetic Algorithm: NSGA-II: Introduction

Lecture 22 - Non-Dominated Genetic Algorithm: NSGA-II: Simulations

Lecture 23 - Strength Pareto Evolutionary Algorithm: SPEA2: Introduction

Lecture 24 - Strength Pareto Evolutionary Algorithm: SPEA2: Simulations

Lecture 25 - Performance Assessment of Multi-Objective EC Techniques

Lecture 26 - Closure of EC for Single and Multi-Objective Optimization

Lecture 1 - Preliminary concepts

Lecture 2 - Fluid Kinematics

Lecture 3 - Derivation of incompressible Navier-Stokes equations

Lecture 4 - Initial and Boundary Conditions

Lecture 5 - Plane Couette Flow

Lecture 6 - Plane Poiseuille Flow

Lecture 7 - Plane Poiseuille Flow with Slip and Thin Film Flow

Lecture 8 - Combined Couette - Poiseuille Flow

Lecture 9 - Example Problems

Lecture 10 - Hagen - Poiseuille Flow

Lecture 11 - Thin Film Flow and Annular Flow

Lecture 12 - Steady Flow Between Rotating Cylinders

Lecture 13 - Flow near a plate suddenly set in motion

Lecture 14 - Flow due to an oscillating plate

Lecture 15 - Transient Plane Couette Flow

Lecture 16 - Transient Axisymmetric Poiseuille Flow

Lecture 17 - Flow Through Rectangular Duct

Lecture 18 - Flow Through Equilateral Triangular Duct

Lecture 19 - Flow Through Elliptical Duct

Lecture 20 - Example Problems

Lecture 21 - Creeping Flow Around a Sphere

Lecture 22 - Reynolds Equation for Lubrication

Lecture 23 - One-dimensional Slider Bearing

Lecture 24 - Journal Bearing and Piston-ring Lubrication

Lecture 25 - Derivation of Boundary Layer Equations

Lecture 26 - Blasius Flow Over A Flat Plate: Similarity Solution

Lecture 27 - Momentum Integral Equation For Flat Plate Boundary Layer

Lecture 28 - Falkner-Skan equation: Boundary layer flow over a wedge

Lecture 29 - Karman-Pohlhausen Method for Non-zero Pressure Gradient Flows

Lecture 30 - The Correlation Method by Thwaites

Lecture 31 - Separation of Boundary Layer

[Lecture 32 - Example Problems](#)

[Lecture 33 - Two-dimensional Laminar Jet](#)

[Lecture 34 - Flow in the Wake of a Flat Plate](#)

[Lecture 35 - Free Shear Layer Between Two Different Streams](#)

[Lecture 36 - Derivation of Orr-Sommerfeld Equation](#)

[Lecture 37 - Viscous Stability](#)

[Lecture 38 - Inviscid Analysis](#)

[Lecture 39 - Introduction to Turbulent Flows](#)

[Lecture 40 - Derivation of Reynolds Averaged Navier-Stokes Equations](#)

[Lecture 41 - External Turbulent Flows](#)

[Lecture 42 - Integral Solution for Turbulent Boundary Layer Flow](#)

[Lecture 43 - Internal Turbulent Flow](#)

[Lecture 44 - Turbulence Modelling](#)

Lecture 1 - Plasma Arc Welding (PAW)

Lecture 2 - Flux Cored Arc Welding (FCAW)

Lecture 3 - Thermit Welding

Lecture 4 - Resistance Welding - Part 1 (Resistance Spot Welding)

Lecture 5 - Resistance Welding - Part 2 (Types of Resistance Welding)

Lecture 6 - Friction Welding

Lecture 7 - Friction Stir Welding - Part 1

Lecture 8 - Friction Stir Welding - Part 2

Lecture 9 - Soldering

Lecture 10 - Brazing

Lecture 11 - Residual Stress - Part 1

Lecture 12 - Residual Stress - Part 2

Lecture 13 - Influencing Factors and Control of Residual Stresses

Lecture 14 - Residual Stress Measurement - 1

Lecture 15 - Residual Stress Measurement - 2

Lecture 16 - Residual Stress Measurement by NDT

Lecture 17 - Welding Induced Distortion

Lecture 18 - Welding Induced Distortion (Control and Measurement)

Lecture 19 - Welding Induced Distortion (Measurement and Prediction)

Lecture 20 - Welded Joint Analysis

Lecture 21 - Welded Joints Analysis (Strength of Parallel and Transverse Fillet Welds)

Lecture 22 - Welded Joints Analysis (Analysis of Eccentrically Loaded Welded Joint)

Lecture 23 - Welded Joints Static Analysis (Analysis of Eccentrically Loaded Welded Joint - Part 1)

Lecture 24 - Welded Joints Static Analysis (Analysis of Eccentrically Loaded Welded Joint - Part 2)

Lecture 25 - Welded Joints Static Analysis (Welded Joint Subjected to Bending Moment)

Lecture 26 - Welded Joints Static Analysis (Welded Joint Subjected to Bending Moment - Part 1)

Lecture 27 - Welded Joints Static Analysis (Welded Joint Subjected to Bending Moment - Part 2)

[Lecture 1 - Introduction to Additive Manufacturing](#)

[Lecture 2 - CAD Models for Additive Manufacturing](#)

[Lecture 3 - Manipulation of STL Files](#)

[Lecture 4 - Slicing Methods - Part A](#)

[Lecture 5 - Slicing Methods - Part B](#)

[Lecture 6 - Toolpath Planning](#)

[Lecture 7 - Demonstration of CAD-CAM Packages](#)

[Lecture 8 - Introduction to Liquid AM](#)

[Lecture 9 - Stereolithography Apparatus: Fundamentals of Photopolymerization - Part 1](#)

[Lecture 10 - Stereolithography Apparatus: Fundamentals of Photopolymerization - Part 2](#)

[Lecture 11 - Stereolithography Apparatus: Sub-systems - Part 1](#)

[Lecture 12 - Stereolithography Apparatus: Sub-systems - Part 2](#)

[Lecture 13 - Other Liquid AM Processes - 1](#)

[Lecture 14 - Other Liquid AM Processes - 2](#)

[Lecture 15 - Sheet Additive Manufacturing - Part 1](#)

[Lecture 16 - Sheet Additive Manufacturing - Part 2](#)

[Lecture 17 - Wire Additive Manufacturing](#)

[Lecture 18 - Fused Deposition Modeling](#)

[Lecture 19 - Metal Wire Additive Manufacturing](#)

[Lecture 20 - Metal Inert Gas-Wire Arc Additive Manufacturing \(MIG-WAAM\) - Part 1](#)

[Lecture 21 - Metal Inert Gas-Wire Arc Additive Manufacturing \(MIG-WAAM\) - Part 2](#)

[Lecture 22 - Tungsten Inert Gas/Plasma-Wire Arc Additive Manufacturing \(TIG/Plasma-WAAM\)](#)

[Lecture 23 - Electron beam-based Wire Beam Additive Manufacturing \(WBAM\)](#)

[Lecture 24 - Laser Metal Wire Additive Manufacturing](#)

[Lecture 25 - Powder-Feed Additive Manufacturing - Part 1](#)

[Lecture 26 - Powder-Feed Additive Manufacturing - Part 2](#)

[Lecture 27 - Process Modeling for Powder Feed Additive Manufacturing - Part 1](#)

[Lecture 28 - Process Modeling for Powder Feed Additive Manufacturing - Part 2](#)

[Lecture 29 - Laser Beam based Powder Bed Additive Manufacturing - Part 1](#)

[Lecture 30 - Laser Beam based Powder Bed Additive Manufacturing - Part 2](#)

[Lecture 31 - Electron Beam based Powder Bed Additive Manufacturing](#)

[Lecture 32 - Binder based Powder Bed Additive Manufacturing - Part 1](#)

[Lecture 33 - Binder based Powder Bed Additive Manufacturing - Part 2](#)

- Lecture 1 - Thermodynamic Systems and Pure Substance
- Lecture 2 - Heat and Work Transfer - First Law of Thermodynamics
- Lecture 3 - Second Law of Thermodynamics
- Lecture 4 - Entropy and Exergy
- Lecture 5 - Introduction to Steam Power Plant
- Lecture 6 - Thermodynamics aspects of Steam Power Plant-Efficiency and Work ratiom
- Lecture 7 - Rankine Cycle and its analysis
- Lecture 8 - Improvement in Rankine Cycle Efficiency: Superheating and Reheating
- Lecture 9 - Improvement in Rankine Cycle Efficiency: Reheating and Regenerative Methods
- Lecture 10 - Improvement in Rankine Cycle Efficiency: Regenerative Methods
- Lecture 11 - Regenerative Cycles
- Lecture 12 - Impulse Steam Turbine: Velocity Diagrams,Work Transfer,Blade Efficiency
- Lecture 13 - Impulse Steam Turbine: Velocity Diagrams,Work Transfer,Blade Efficiency (Continued...)
- Lecture 14 - Reaction Steam Turbine
- Lecture 15 - Reaction Steam Turbine: Velocity Diagram, Work transfer, Blade Efficiency
- Lecture 16 - Steam Nozzle: Analysis and Efficiency
- Lecture 17 - Steam Nozzle: Analysis and Efficiency (Continued...)
- Lecture 18 - Boilers and Condensers
- Lecture 19 - Condensers and Second Law Analysis of Steam Power cycle
- Lecture 20 - Exergy Analysis of a Steam Turbine
- Lecture 21 - Numerical Problems: Steam Power Cycle
- Lecture 22 - IC engine-Components, Nomenclature and Classifications
- Lecture 23 - Basic Engine Cycle and Engine Kinematic Analysis
- Lecture 24 - Engine Operating Characteristics
- Lecture 25 - Thermodynamics Analysis of Air Standard Cycles
- Lecture 26 - Valve Timing Diagram and Fuel-Air Cycle
- Lecture 27 - Thermochemistry and Fuel Characteristics
- Lecture 28 - Combustion Phenomena in Engines
- Lecture 29 - Heat Transfer Analysis in Engines
- Lecture 30 - Exergy Analysis and Engine Emission/Pollution
- Lecture 31 - Gas Turbine Engine-Components and Thermal Circuit



- [Lecture 32 - Gas Turbine Performance Cycle - I](#)
- [Lecture 33 - Gas Turbine Performance Cycle - II](#)
- [Lecture 34 - Real Gas Turbine Performance Cycle](#)
- [Lecture 35 - Aircraft Propulsion Cycle - I](#)
- [Lecture 36 - Aircraft Propulsion Cycle - II](#)
- [Lecture 37 - Vapour Compression Refrigeration System - I](#)
- [Lecture 38 - Vapour Compression Refrigeration System - II](#)
- [Lecture 39 - Absorption Refrigeration and Refrigerants](#)
- [Lecture 40 - Fundamentals of Psychrometrics](#)
- [Lecture 41 - Air-Conditioning Processes](#)
- [Lecture 42 - Cooling Tower and Air Washers](#)
- [Lecture 43 - Reciprocating Compressor - Analysis and Modelling](#)
- [Lecture 44 - Multistage Compression - Analysis and Modelling](#)

- Lecture 1 - Composite Materials - Introduction
- Lecture 2 - Composite Materials - Classification
- Lecture 3 - Anisotropic Elasticity
- Lecture 4 - Orthotropic Materials
- Lecture 5 - Hooke's Law for 2D Lamina
- Lecture 6 - Engineering Constants for 2D Lamina
- Lecture 7 - Strength Failure Criteria - Part I
- Lecture 8 - Strength Failure Criteria - Part II
- Lecture 9 - Hygrothermal Behavior of Lamina
- Lecture 10 - Introduction and Terminologies
- Lecture 11 - Evaluation of Elastic Moduli
- Lecture 12 - Evaluation of Longitudinal Strength
- Lecture 13 - Evaluation of Transverse and Shear Strengths
- Lecture 14 - Evaluation of Hygrothermal Properties
- Lecture 15 - Elasticity Approach
- Lecture 16 - Experimental Evaluation
- Lecture 17 - Laminate - Introduction
- Lecture 18 - Classical Lamination Theory - Part I
- Lecture 19 - Classical Lamination Theory - Part II
- Lecture 20 - Response of Laminate - Significance of ABBD
- Lecture 21 - Special Classes of Laminates
- Lecture 22 - Engineering Constants of Laminates
- Lecture 23 - Hygrothermal Behaviour of Laminates
- Lecture 24 - Analysis of Laminates
- Lecture 25 - Failure of Laminates
- Lecture 26 - Failure Analysis under Combined Loading
- Lecture 27 - Design Example - I
- Lecture 28 - Design Example - II
- Lecture 29 - Interlaminar Stresses- Delamination
- Lecture 30 - Prediction of Delamination
- Lecture 31 - Transverse Deflection

Lecture 32 - Buckling and Free Vibration

Lecture 1 - Lasers in Manufacturing: Importance and Applications

Lecture 2 - Fundamentals of Laser Technology

Lecture 3 - Laser System: Construction and Types

Lecture 4 - Principle of Operation, Types of Laser Cutting, and Kerf Geometry

Lecture 5 - Types of Lasers in Material Removal, Process and Performance Parameters

Lecture 6 - A Case-study on Cutting a Circular Part using CO2 Laser Machine

Lecture 7 - Mechanisms of Laser Welding - Part I

Lecture 8 - Mechanisms of Laser Welding - Part II

Lecture 9 - Effects of Process Parameters during Laser Welding and Study of Defects in Weld Beads

Lecture 10 - A Case Study on Welding of Mild Steel Sheets using 2.5 kW CO2 Laser Machine

Lecture 11 - Material Forming and Fundamentals of Laser Forming

Lecture 12 - Mechanisms of Laser Forming

Lecture 13 - Process Parameters and their Effects on the Performance of Laser Forming

Lecture 14 - Surface Treatment and Application of Lasers

Lecture 15 - Laser Surface Hardening

Lecture 16 - Laser Surface Alloying

Lecture 17 - Laser Cladding

Lecture 18 - Additive Manufacturing Techniques

Lecture 19 - Laser Scanning Stereolithography

Lecture 20 - Selective Laser Sintering and Selective Laser Melting

Lecture 21 - Process and Performance Parameters of Laser Based Additive Manufacturing Techniques

Lecture 22 - Lasers in Manufacturing Automation

Lecture 23 - CNC for Laser Based Manufacturing

Lecture 24 - CAD for Laser Based Manufacturing

Lecture 25 - Laser-assisted Material Forming

Lecture 26 - Effect of Coatings, 3D Laser Forming and Micro-forming

- Lecture 1 - Temperature and Zeroth Law of Thermodynamics
- Lecture 2 - Work and Heat Transfer - First Law of Thermodynamics
- Lecture 3 - Heat Engines and Refrigerators/Heat Pump - Second Law of Thermodynamics
- Lecture 4 - Entropy Analysis - Part I
- Lecture 5 - Entropy Analysis - Part II
- Lecture 6 - Entropy Analysis - Part III
- Lecture 7 - Exergy Analysis - Part I
- Lecture 8 - Exergy Analysis - Part II
- Lecture 9 - Exergy Analysis - Part III
- Lecture 10 - Thermodynamic Functions and Maxwell's Equations
- Lecture 11 - Property Relations for Phase Change Processes
- Lecture 12 - Property Relations for Single Phase Systems
- Lecture 13 - Heat Capacity Equations and its Applications
- Lecture 14 - Joule - Thomson Coefficient and Liquefaction of Gases
- Lecture 15 - Ideal Gas and Real Gas
- Lecture 16 - Gas Mixtures and Multi-Component System
- Lecture 17 - Ideal Gas Mixture
- Lecture 18 - Mixing Analysis of Thermodynamic Systems
- Lecture 19 - Thermodynamic Considerations of Combustion
- Lecture 20 - Conservation of Energy for Reacting Systems
- Lecture 21 - Adiabatic Flame Temperature, Entropy and Gibbs Function for Reacting System
- Lecture 22 - Equilibrium Products of Combustion and Effective Energy Utilization
- Lecture 23 - Fundamentals of Chemical Reactions
- Lecture 24 - Reaction Mechanisms - Part I
- Lecture 25 - Reaction Mechanisms - Part II
- Lecture 26 - Chemical and Thermal Analysis of Reacting Systems
- Lecture 27 - Simplified Conservation Equations for Reacting Flows
- Lecture 28 - Laminar Premixed Flame - Part I
- Lecture 29 - Laminar Premixed Flame - Part II
- Lecture 30 - Laminar Diffusion Flame
- Lecture 31 - Droplet Evaporation and Turbulent Flame

Lecture 32 - Engine Combustion and Pollution

- Lecture 1 - First law of Thermodynamics for control mass and control volume systems
- Lecture 2 - First law of Thermodynamics for control volume system (Flow system)
- Lecture 3 - Steady State Steady Flow Processes, combination of First and Second Laws
- Lecture 4 - Second Law of Thermodynamics: A Brief Review
- Lecture 5 - Combined First and Second Laws Applied to Processes
- Lecture 6 - Combined First and Second Laws: Flow and Non-Flow Processes
- Lecture 7 - Description of Steam Power Plant: Application of 1st and 2nd Laws to Different Processes
- Lecture 8 - Second Law Applied to Processes of Power Plant and Ideal Cycle of Power Plant
- Lecture 9 - Steam Power Plant: Thermodynamic aspects, Efficiency, Work ratio and Ideal Cycle
- Lecture 10 - Ideal Power Cycle and its Limitations, Introduction to Actual Power Cycle
- Lecture 11 - Limitations of Carnot Cycle, Simple Rankine Cycle and Analysis
- Lecture 12 - Analysis of Simple Rankine Cycle and its Design Modifications
- Lecture 13 - Reheat Cycle and Analysis
- Lecture 14 - Reheat Cycle and Analysis (Continued...)
- Lecture 15 - Regenerative Principle of Steam Power Cycles
- Lecture 16 - Analysis of Regenerative Steam Power Cycles
- Lecture 17 - Regenerative Steam Power Cycle with Closed Feed-Water Heater, Ideal Working Fluid
- Lecture 18 - Multi-fluid Cycle and Analysis
- Lecture 19 - Analysis of Multi-fluid Cycle; Second Law Analysis of Steam Power Cycle
- Lecture 20 - Problems of Steam Power Cycle
- Lecture 21 - Problems of Steam Power Cycle (Continued...)
- Lecture 22 - Types of Boiler, Different Cycles in Boiler Operation, Boiler attachment
- Lecture 23 - Cochran Boiler Operation, Boiler attachment
- Lecture 24 - Boiler Attachments
- Lecture 25 - Superheaters and their Arrangements, Steam Temperature Control
- Lecture 26 - Characteristics of Convective and Radiant Superheaters; Steam Temperature Control
- Lecture 27 - Problems on Boiler/Steam Generator
- Lecture 28 - Use of nozzles in steam power plant, flow analysis of steam in nozzle
- Lecture 29 - Flow analysis of steam in nozzle: Mass flow rate
- Lecture 30 - Mass flow rate of steam in nozzle, Critical Pressure Ratio
- Lecture 31 - Critical Pressure Ratio and its Physical Significance

- Lecture 32 - Nozzle efficiency and factors that affect the efficiency
- Lecture 33 - Factors that affect the efficiency, problem on flow nozzle
- Lecture 34 - Problem on flow nozzle
- Lecture 35 - Steam Turbines: types and analysis using velocity triangles
- Lecture 36 - Analysis of Impulse Steam Turbine
- Lecture 37 - Compounding of Steam Turbine
- Lecture 38 - Analysis of Reaction Steam Turbine
- Lecture 39 - Problems on Steam Turbine
- Lecture 40 - The Role of Condenser in Power Plant
- Lecture 41 - Cooling Tower: Types and Analysis
- Lecture 42 - Cooling Tower Performance
- Lecture 43 - IC Engines, Classification, Different Parts, SI and CI Engines
- Lecture 44 - Comparison of 2-stroke and 4-stroke Engines
- Lecture 45 - Comparison of SI and CI Engines, Compression Ratio
- Lecture 46 - Introduction to Carburettor and Regimes of Engine Operation
- Lecture 47 - Regimes of Engine Operation and Simple Float Type Carburettor
- Lecture 48 - Simple Float Type Carburettor and its Analysis
- Lecture 49 - Mass Flow Rate of Fuel and limitations of Simple Float Type Carburettor
- Lecture 50 - Limitations of Simple Float Type Carburettor, Problem on Carburettion
- Lecture 51 - Engine Operating Characteristics: MEP and Indicator diagram
- Lecture 52 - Performance Analysis parameters of IC Engine
- Lecture 53 - Fuel of IC Engines
- Lecture 54 - Alternative Fuels and Self Ignition Characteristics of Fuel: Octane Number, Cetane Number
- Lecture 55 - Thermodynamic Analysis of SI Engine
- Lecture 56 - Thermodynamic Analysis of CI Engine
- Lecture 57 - Numerical Problems on Engine Performance
- Lecture 58 - Pressure-Crank angle diagram, Engine Efficiencies
- Lecture 59 - Numerical Problems on SI and CI Engines
- Lecture 60 - Vapour Compression Refrigeration Cycle and its analysis
- Lecture 61 - Problems on Vapour Compression Refrigeration Cycle
- Lecture 62 - Gas Turbine Units and Thermodynamic Cycles
- Lecture 63 - Gas Compressor and Optimum Pressure Ratio
- Lecture 64 - Compressor Efficiency and Multistage Compression with Intercooling



[Lecture 65 - Gas Turbine Unit: Combined Cycle](#)

[Lecture 66 - Problems On Gas Turbine Cycle](#)

Lecture 1 - Introduction to sheet forming and tensile test of sheets

Lecture 2 - Tensile test, effect of properties, exercise problem

Lecture 3 - Sheet deformation processes

Lecture 4 - Sheet deformation processes (Continued...)

Lecture 5 - Sheet deformation processes (Continued...)

Lecture 6 - Sheet deformation in plane stress

Lecture 7 - Sheet deformation in plane stress (Continued...)

Lecture 8 - Stamping analyses

Lecture 9 - Load instability and tearing

Lecture 10 - Load instability and tearing

Lecture 11 - Formability testing of sheet metals

Lecture 12 - Sheet formability

Lecture 13 - Sheet formability (Continued...)

Lecture 14 - Bending of sheets

Lecture 15 - Bending of sheets (Continued...)

Lecture 16 - Cup deep drawing

Lecture 17 - Deep drawing, redrawing, ironing of cup

Lecture 18 - Stretching of sheet

Lecture 19 - Hydroforming

Lecture 20 - Yield functions with sheet anisotropy

Lecture 21 - Demonstration of sheet forming experiments

Lecture 1 - Thermodynamics Concepts - Part I

Lecture 2 - Thermodynamics Concepts - Part II

Lecture 3 - Thermodynamic Analysis of Vapor Power Cycle

Lecture 4 - Rankine Cycle

Lecture 5 - Modified Rankine Cycle

Lecture 6 - Exergy Analysis of Vapor Power Cycles

Lecture 7 - Rotodynamic Machines

Lecture 8 - Impulse Turbine

Lecture 9 - Reaction Turbine

Lecture 10 - Performance Analysis of Steam Turbines

Lecture 11 - Steam Nozzles - Part I

Lecture 12 - Steam Nozzles - Part II

Lecture 13 - Steam Generator

Lecture 14 - Water Tube Boiler - Part I

Lecture 15 - Water Tube Boiler - Part II

Lecture 16 - Fuels and Combustion - Part I

Lecture 17 - Fuels and Combustion - Part II

Lecture 18 - Steam Condenser

Lecture 19 - Feed Water Heaters

Lecture 20 - Cooling Towers

Lecture 21 - Fundamentals of Gas turbine systems

Lecture 22 - Modifications of Brayton cycle

Lecture 23 - Combined Power cycle

Lecture 24 - Gas Turbines for Aircraft Propulsion

Lecture 25 - Hydro-Power System - Part I

Lecture 26 - Hydro-Power System - Part II

Lecture 27 - Wind Energy - Part I

Lecture 28 - Wind Energy - Part II

Lecture 29 - Energy From Oceans - Part I

Lecture 30 - Energy From Oceans - Part II

Lecture 31 - Geothermal Energy

[Lecture 32 - Energy Storage - I](#)

[Lecture 33 - Energy Storage - II](#)

[Lecture 34 - Energy Storage - III](#)

- Lecture 1 - Introduction to phase diagrams
- Lecture 2 - Thermodynamic relations
- Lecture 3 - Single component system and binary solutions
- Lecture 4 - Regular solutions
- Lecture 5 - Real solutions
- Lecture 6 - Phase transformations
- Lecture 7 - Practice problems (Module 1)
- Lecture 8 - Introduction to homogenous nucleation process
- Lecture 9 - Fundamental to heterogeneous nucleation
- Lecture 10 - Growth of pure metal
- Lecture 11 - Alloy solidification
- Lecture 12 - Formation of different S/L interface
- Lecture 13 - Solidification structures and segregation
- Lecture 14 - Weld Metal Solidification and Microstructure - I
- Lecture 15 - Weld Metal Solidification and Microstructure - II
- Lecture 16 - Solidification of additive manufacturing - I
- Lecture 17 - Solidification of additive manufacturing - II
- Lecture 18 - Rate of solidification-sand casting
- Lecture 19 - Rate of solidification-die casting
- Lecture 20 - Riser design and solidification of pure metal
- Lecture 21 - Zone melting and rapid solidification
- Lecture 22 - Semisolid processing and other solidification techniques
- Lecture 23 - Demonstration of the solidification process and numerical problems

- Lecture 1 - Materials and microstructure evolutions - 1
- Lecture 2 - Materials and microstructure evolutions - 2
- Lecture 3 - Materials and microstructure evolutions - 3
- Lecture 4 - Basics of heat conduction - 1
- Lecture 5 - Basics of heat conduction - 2
- Lecture 6 - Basics of heat conduction - 3
- Lecture 7 - Basics of heat conduction - 4
- Lecture 8 - Basics of fluid flow - 1
- Lecture 9 - Basics of fluid flow - 2
- Lecture 10 - Solidification processing - 1
- Lecture 11 - Solidification processing - 2
- Lecture 12 - Casting and welding - 1
- Lecture 13 - Casting and welding - 2
- Lecture 14 - Casting and welding - 3
- Lecture 15 - Casting and welding - 4
- Lecture 16 - Material forming
- Lecture 17 - Material forming: Numerical problem
- Lecture 18 - Processing of metal: Casting Process - I
- Lecture 19 - Processing of metal: Casting Process - II
- Lecture 20 - Processing of polymer: Thermoplastic and thermosets
- Lecture 21 - Processing of polymer: Extrusion
- Lecture 22 - Processing of polymer: Injection molding
- Lecture 23 - Processing of polymer: Blow molding
- Lecture 24 - Processing of polymer: Thermosets
- Lecture 25 - Processing of ceramics - I
- Lecture 26 - Processing of ceramics - II
- Lecture 27 - Processing of glasses and fused deposition modeling
- Lecture 28 - Arc welding processes
- Lecture 29 - Welding of polymers
- Lecture 30 - Laser and electron beam welding processes
- Lecture 31 - Advanced welding processes

[Lecture 32 - Welding solidification](#)

[Lecture 33 - Metallic wire additive manufacturing](#)

[Lecture 34 - Mechanical responses of metals and polymers](#)

[Lecture 35 - Hot working and cold working](#)

[Lecture 36 - Types of metal forming processes - I](#)

[Lecture 37 - Types of metal forming processes - II](#)

[Lecture 38 - Types of metal forming processes - III and Hot rolling of steel](#)

[Lecture 39 - Solid state deformation - 1](#)

[Lecture 40 - Solid state deformation - 2](#)

[Lecture 41 - Powder processing - 1](#)

[Lecture 42 - Powder processing - 2](#)

[Lecture 43 - Powder processing - 3](#)

[Lecture 44 - Ceramic processing: Dry pressing and plastic forming methods](#)

[Lecture 45 - Ceramic processing: Colloidal processing, casting, and coating techniques](#)

[Lecture 46 - Introduction to steel making and single crystal production](#)

[Lecture 47 - Integrated Analysis of Steel Solidification, Fluid Flow, and Powder Processing Technologies](#)

[Lecture 48 - Processing of electronics Materials, A case Study: semiconductor measurements](#)

[Lecture 49 - Processing of magnetic materials and Processing of magnetic materials for advanced materials](#)

[Lecture 50 - Processing of optics materials and pertaining case study](#)

**NPTEL : Acoustics (Mechanical Engineering)**

**Co-ordinators : Prof. Nachiketa Tiwari**

Lecture 1 - Intro, sound wave versus vibration, different types of waves, octave, music scales, sense of SPL

Lecture 2 - Review: Linearity, complex numbers, and spring mass system

Lecture 3 - Review: Poles and zeroes, phase and magnitude plots, transfer functions, Bode plots

Lecture 4 - Review: Transfer functions, and Bode plots

Lecture 5 - 1-D wave equation, and its solution

Lecture 6 - Solution for 1-D wave equation

Lecture 7 - Waveguides, transmission line equations, and standing waves

Lecture 8 - Waveguides, transmission line equations, and standing waves

Lecture 9 - Examples of 1-D waves in tubes, short tubes, Kundt's tube

Lecture 10 - Thermodynamic processes during sound transmission

Lecture 11 - Numerical examples

Lecture 12 - Sound transmission through walls

Lecture 13 - Sound transmission through walls

Lecture 14 - Leakage in walls, STC Ratings, Octave bands

Lecture 15 - Instantaneous power flow

Lecture 16 - Radial propagation of sound, monopoles, and dipoles

Lecture 17 - Radial propagation of sound, monopoles, and dipoles

Lecture 18 - Radial propagation of sound, monopoles, and dipoles

Lecture 19 - Numerical examples

Lecture 20 - Numerical examples

Lecture 21 - Directivity

Lecture 22 - Directivity

Lecture 23 - Directivity

Lecture 24 - Directivity

Lecture 25 - Generalized elements

Lecture 26 - Examples of electromechanical systems

Lecture 27 - Transformers, radiation impedance, and Helmholtz resonator

Lecture 28 - Radiation impedance

Lecture 29 - Radiation impedance

Lecture 30 - Models of electro-mechanical-acoustic systems

Lecture 31 - Solution for a loudspeaker model



[Lecture 32 - Microphones](#)

[Lecture 33 - Vibro-meter, seismometer, accelerometer, shaker table](#)

[Lecture 34 - Sound propagation in rooms, 1-D rooms, 2D rooms](#)

[Lecture 35 - Sound in 3-D rooms](#)

[Lecture 36 - Absorption coefficient, and irregular rooms](#)

[Lecture 37 - Room constant, and Sabine's coefficient](#)

[Lecture 38 - Design of a muffler](#)

[Lecture 39 - Noise in machines, basics of noise management](#)

**NPTEL : Advanced Machining Processes (Mechanical Engineering)**

**Co-ordinators : Prof. Vijay K. Jain**

[Lecture 1 - Advanced Machining Processes](#)

[Lecture 2 - Advanced Machining Processes](#)

[Lecture 3 - Advanced Machining Processes](#)

[Lecture 4 - Advanced Machining Processes](#)

[Lecture 5 - Advanced Machining Processes](#)

[Lecture 6 - Advanced Machining Processes](#)

[Lecture 7 - Advanced Machining Processes](#)

[Lecture 8 - Advanced Machining Processes](#)

[Lecture 9 - Advanced Machining Processes](#)

[Lecture 10 - Advanced Machining Processes](#)

[Lecture 11 - Advanced Machining Processes](#)

[Lecture 12 - Advanced Machining Processes](#)

[Lecture 13 - Advanced Machining Processes](#)

[Lecture 14 - Advanced Machining Processes](#)

[Lecture 15 - Advanced Machining Processes](#)

[Lecture 16 - Advanced Machining Processes](#)

[Lecture 17 - Advanced Machining Processes](#)

[Lecture 18 - Advanced Machining Processes](#)

[Lecture 19 - Advanced Machining Processes](#)

[Lecture 20 - Advanced Machining Processes](#)

[Lecture 21 - Advanced Machining Processes](#)

[Lecture 22 - Advanced Machining Processes](#)

[Lecture 23 - Advanced Machining Processes](#)

[Lecture 24 - Advanced Machining Processes](#)

[Lecture 25 - Advanced Machining Processes](#)

[Lecture 26 - Advanced Machining Processes](#)

[Lecture 27 - Advanced Machining Processes](#)

[Lecture 28 - Advanced Machining Processes](#)

[Lecture 29 - Advanced Machining Processes](#)

[Lecture 30 - Advanced Machining Processes](#)

[Lecture 31 - Advanced Machining Processes](#)

[Lecture 32 - Advanced Machining Processes](#)

[Lecture 33 - Advanced Machining Processes](#)

[Lecture 34 - Advanced Machining Processes](#)

[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10 \(same as 9\)](#)

[Lecture 11](#)

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

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

[Lecture 20](#)

[Lecture 21](#)

[Lecture 22](#)

[Lecture 23](#)

[Lecture 24](#)

[Lecture 25](#)

[Lecture 26](#)

[Lecture 27](#)

[Lecture 28](#)

[Lecture 29](#)

[Lecture 30](#)

[Lecture 31](#)

[Lecture 32](#)

[Lecture 33](#)

[Lecture 34](#)

[Lecture 35](#)

[Lecture 36](#)

[Lecture 37](#)

[Lecture 38](#)

[Lecture 39](#)

[Lecture 40](#)

[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10](#)

[Lecture 11](#)

[Lecture 12](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

[Lecture 20](#)

[Lecture 21](#)

[Lecture 22](#)

[Lecture 23](#)

[Lecture 24](#)

[Lecture 25](#)

[Lecture 26](#)

[Lecture 27](#)

[Lecture 28](#)

[Lecture 29](#)

[Lecture 30](#)

[Lecture 31](#)

[Lecture 32](#)

[Lecture 33](#)

[Lecture 34](#)

[Lecture 35](#)

[Lecture 36](#)

[Lecture 37](#)

[Lecture 38](#)

[Lecture 39](#)

[Lecture 40](#)

Lecture 1 - Introduction

Lecture 2 - Basic Ideas of Applied Linear Algebra

Lecture 3 - Systems of Linear Equations

Lecture 4 - Square Non-Singular Systems

Lecture 5 - Ill-Conditioned and Ill-Posed Systems

Lecture 6 - The Algebraic Eigenvalue Problem

Lecture 7 - Canonical Forms, Symmetric Matrices

Lecture 8 - Methods of Plane Rotations

Lecture 9 - Householder Method, Tridiagonal Matrices

Lecture 10 - QR Decomposition, General Matrices

Lecture 11 - Singular Value Decomposition

Lecture 12 - Vector Space: Concepts

Lecture 13 - Multivariate Calculus

Lecture 14 - Vector Calculus in Geometry

Lecture 15 - Vector Calculus in Physics

Lecture 16 - Solution of Equations

Lecture 17 - Introduction to Optimization

Lecture 18 - Multivariate Optimization

Lecture 19 - Constrained Optimization: Optimality Criteria

Lecture 20 - Constrained Optimization: Further Issues

Lecture 21 - Interpolation

Lecture 22 - Numerical Integration

Lecture 23 - Numerical Solution of ODE's as IVP

Lecture 24 - Boundary Value Problems, Question of Stability in IVP Solution

Lecture 25 - Stiff Differential Equations, Existence and Uniqueness Theory

Lecture 26 - Theory of First Order ODE's

Lecture 27 - Linear Second Order ODE's

Lecture 28 - Methods of Linear ODE's

Lecture 29 - ODE Systems

Lecture 30 - Stability of Dynamic Systems

Lecture 31 - Series Solutions and Special Functions



[Lecture 32 - Sturm-Liouville Theory](#)

[Lecture 33 - Approximation Theory and Fourier Series](#)

[Lecture 34 - Fourier Integral to Fourier Transform, Minimax Approximation](#)

[Lecture 35 - Separation of Variables in PDE's, Hyperbolic Equations](#)

[Lecture 36 - Parabolic and Elliptic Equations, Membrane Equation](#)

[Lecture 37 - Analytic Functions](#)

[Lecture 38 - Integration of Complex Functions](#)

[Lecture 39 - Singularities and Residues](#)

[Lecture 40 - Calculus of Variations](#)

**NPTEL : Dynamics of Machines (Mechanical Engineering)**

**Co-ordinators : Prof. Amitabha Ghosh**

Lecture 1 - Rigid Body Motion - Part 1

Lecture 2 - Rigid Body Motion - Part 2

Lecture 3 - Dynamic Force Analysis of Mechanisms

Lecture 4 - Space Motion of Rigid Bodies

Lecture 5 - Inertia Tensor Angular Momentum

Lecture 6 - Euler's Equation of Motion

Lecture 7 - Gyroscopic Action in Machines

Lecture 8 - Unbalance in Machines

Lecture 9 - Rotary Balancing

Lecture 10 - Balancing Machines

Lecture 11 - Field Balancing of Rotors

Lecture 12 - Single-Cylinder Engine Balancing

Lecture 13 - Balancing of Single Slider Machines

Lecture 14 - In-Line Engine Balancing

Lecture 15 - V and Radial Engine Balancing

Lecture 16 - Turning Moment Diagram

Lecture 17 - Flywheel Analysis

Lecture 18 - Dynamics of Machines

Lecture 19 - Dynamics of Machines

Lecture 20 - Dynamics of Machines

Lecture 21 - Dynamics of Machines

Lecture 22 - Dynamics of Machines

Lecture 23 - Dynamics of Machines

Lecture 24 - Dynamics of Machines

Lecture 25 - Dynamics of Machines

Lecture 26 - Dynamics of Machines

Lecture 27 - Dynamics of Machines

Lecture 28 - Dynamics of Machines

Lecture 29 - Rotating Vector Approach

Lecture 30 - Equivalent viscous damping

Lecture 31 - Dynamics of Machines

[Lecture 32 - Systems with two degree of freedom](#)

[Lecture 33 - Tuned Vibration Absorber](#)

[Lecture 34 - Design of Vibration Absorbers](#)

[Lecture 35 - Flexibility Matrix Influence Coeff](#)

[Lecture 36 - Forced Vibration of multiple](#)

[Lecture 37 - Forced Vibration of Multiple degrees](#)

[Lecture 38 - Vibration of Continuous Systems](#)

[Lecture 39 - Vibration of Continuous Systems](#)

[Lecture 40 - Vibration of Beams](#)

[Lecture 41 - Rayleigh's method](#)

[Lecture 42 - Rayleigh-Ritz Method](#)

[Lecture 43 - Vibration Measurement](#)

[Lecture 44 - Vibration Measurement Types of Pickups](#)

**NPTEL : Finite Element Method (Mechanical Engineering)**

**Co-ordinators : Prof. C.S. Upadhyay**

[Module 1 - Lecture 1](#)

[Module 1 - Lecture 2](#)

[Module 1 - Lecture 3](#)

[Module 2 - Lecture 1](#)

[Module 2 - Lecture 2](#)

[Module 2 - Lecture 3](#)

[Module 2 - Lecture 4](#)

[Module 3 - Lecture 1](#)

[Module 3 - Lecture 2](#)

[Module 3 - Lecture 3](#)

[Module 4 - Lecture 1](#)

[Module 4 - Lecture 2](#)

[Module 4 - Lecture 3](#)

[Module 5 - Lecture 1](#)

[Module 5 - Lecture 2](#)

[Module 5 - Lecture 3](#)

[Module 6 - Lecture 1](#)

[Module 6 - Lecture 2](#)

[Module 6 - Lecture 3](#)

[Module 7 - Lecture 1](#)

[Module 7 - Lecture 2](#)

[Module 7 - Lecture 3](#)

[Module 7 - Lecture 4](#)

[Module 8 - Lecture 1](#)

[Module 8 - Lecture 2](#)

[Module 8 - Lecture 3](#)

[Module 9 - Lecture 1](#)

[Module 9 - Lecture 2](#)

[Module 9 - Lecture 3](#)

[Module 10 - Lecture 1](#)

[Module 10 - Lecture 2](#)

[Module 11 - Lecture 1](#)

[Module 11 - Lecture 2](#)

[Module 12 - Lecture 1](#)

[Module 13 - Lecture 1](#)

[Module 13 - Lecture 2](#)

[Module 14 - Lecture 1](#)

[Module 14 - Lecture 2](#)

**NPTEL : Kinematics of Machines (Mechanical Engineering)**

**Co-ordinators : Prof. Ashok K Mallik**

[Module 1 - Lecture 1](#)  
[Module 1 - Lecture 2](#)  
[Module 1 - Lecture 3](#)  
[Module 2 - Lecture 1](#)  
[Module 2 - Lecture 2](#)  
[Module 2 - Lecture 3](#)  
[Module 3 - Lecture 1](#)  
[Module 3 - Lecture 2](#)  
[Module 3 - Lecture 3](#)  
[Module 3 - Lecture 4](#)  
[Module 4 - Lecture 1](#)  
[Module 4 - Lecture 2](#)  
[Module 5 - Lecture 1](#)  
[Module 5 - Lecture 2](#)  
[Module 5 - Lecture 3](#)  
[Module 6 - Lecture 1](#)  
[Module 6 - Lecture 2](#)  
[Module 6 - Lecture 3](#)  
[Module 7 - Lecture 1](#)  
[Module 7 - Lecture 2](#)  
[Module 7 - Lecture 3](#)  
[Module 8 - Lecture 1](#)  
[Module 8 - Lecture 2](#)  
[Module 9 - Lecture 1](#)  
[Module 9 - Lecture 2](#)  
[Module 9 - Lecture 3](#)  
[Module 9 - Lecture 4](#)  
[Module 10 - Lecture 1](#)  
[Module 10 - Lecture 2](#)  
[Module 10 - Lecture 3](#)  
[Module 11 - Lecture 1](#)

[Module 11 - Lecture 2](#)

[Module 11 - Lecture 3](#)

[Module 12 - Lecture 1](#)

[Module 12 - Lecture 2](#)

[Module 12 - Lecture 3](#)

[Module 13 - Lecture 1](#)

[Module 13 - Lecture 2](#)

[Module 13 - Lecture 3](#)

[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10](#)

[Lecture 11](#)

[Lecture 12](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

[Lecture 20](#)

[Lecture 21](#)

[Lecture 22](#)

[Lecture 23](#)

[Lecture 24](#)

[Lecture 25](#)

[Lecture 26](#)

[Lecture 27](#)

[Lecture 28](#)

[Lab session 1 - Advanced manufacturing process for micro sytem fabrication](#)

[Lab session 2 - EDM Micro Machening](#)

[Lab session 3 - EDM Micro Drilling](#)



[Lab session 4 - Laser Machening Process](#)

[Lab session 5 - Vaccume Assisted Forming](#)

[Lab session 6 - Vaccume Forming](#)

[Lab session 7 - Photolithiography](#)

[Lab session 8 - Replication part 1](#)

[Lab session 9 - Replication part 2](#)

[Lab session 10 - PCB Making](#)

[Lecture 1 - Technical Arts 101](#)

[Lecture 2 - Technical Arts 101](#)

[Lecture 3 - Technical Arts 101](#)

[Lecture 4 - Technical Arts 101](#)

[Lecture 5 - Technical Arts 101](#)

[Lecture 6 - Technical Arts 101](#)

[Lecture 7 - Technical Arts 101](#)

[Lecture 8 - Technical Arts 101](#)

[Lecture 9 - Technical Arts 101](#)

[Lecture 10 - Technical Arts 101](#)

[Lecture 11 - Technical Arts 101](#)

[Lecture 12 - Technical Arts 101](#)

[Lecture 13 - Technical Arts 101](#)

[Lecture 14 - Technical Arts 101](#)

[Lecture 15 - Technical Arts 101](#)

[Lecture 16 - Technical Arts 101](#)

[Lecture 17 - Technical Arts 101](#)

[Lecture 18 - Technical Arts 101](#)

[Lecture 19 - Technical Arts 101](#)

[Lecture 20 - Technical Arts 101](#)

[Lecture 21 - Technical Arts 101](#)

[Lecture 22 - Technical Arts 101](#)

[Lecture 23 - Technical Arts 101](#)

[Lecture 24 - Technical Arts 101](#)

[Lecture 25 - Technical Arts 101](#)

[Lecture 26 - Technical Arts 101](#)

[Lecture 27 - Technical Arts 101](#)

[Lecture 28 - Technical Arts 101](#)

[Lab Session 1](#)

[Lab Session 2](#)

[Lab Session 3](#)

[Lab Session 4](#)

[Lab Session 5](#)

[Lab Session 6](#)

[Lab Session 7](#)

[Lab Session 8](#)

[Lab Session 9](#)

[Lab Session 10](#)

[Lab Session 11](#)

[Lab Session 12](#)

Lecture 1 - Lecture 1

Lecture 2 - Lecture 2

Lecture 3 - Lecture 3

Lecture 4 - Review Lecture 1,2,3

Lecture 5 - Lecture 4

Lecture 6 - Lecture 5

Lecture 7 - Lecture 6

Lecture 8 - Review Lecture 4,5,6

Lecture 9 - Lecture 7

Lecture 10 - Lecture 8

Lecture 11 - Lecture 9-10

Lecture 12 - Lecture-11

Lecture 13 - Lecture-12

Lecture 14 - Lecture-13

Lecture 15 - Lecture-14

Lecture 16 - Lecture-15

Lecture 17 - Lecture-16

Lecture 18 - Lecture-17

Lecture 19 - Lecture-18

Lecture 20 - Lecture-19

Lecture 21 - Review Lecture 7 to 10

Lecture 22 - Review Lecture 11 to 13

Lecture 23 - Review Lecture 14 to 16

Lecture 24 - Lecture-20

Lecture 25 - Lecture-21

Lecture 26 - Lecture-22

Lecture 27 - Lecture-23

Lecture 28 - Lecture-24

Lecture 29 - Lecture-25

Lecture 30 - Review Lecture 17,18,19

Lecture 31 - Review Lecture 20,21,22

[Lecture 32 - Lecture-26](#)

[Lecture 33 - Lecture-27](#)

[Lecture 34 - Lecture-28](#)

[Lecture 35 - Lecture-29](#)

[Lecture 36 - Lecture-30](#)

[Lecture 37 - Lecture-31](#)

[Lecture 38 - Lecture-32](#)

[Lecture 39 - Lecture-33](#)

[Lecture 40 - Review lecture 23,24,25](#)

[Lecture 41 - Review lecture 26,27,28](#)

[Lecture 42 - Review lecture 29 to 33](#)

[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10](#)

[Lecture 11](#)

[Lecture 12](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

[Lecture 20](#)

[Lecture 21](#)

[Lecture 22](#)

[Lecture 23](#)

[Lecture 24](#)

[Lecture 25](#)

[Lecture 26](#)

[Lecture 27](#)

[Lecture 28](#)

[Lecture 29](#)

[Lecture 30](#)

[Lecture 31](#)

[Lecture 32](#)

[Lecture 33](#)

[Lecture 34](#)

[Lecture 35](#)

[Lecture 36](#)

[Lecture 37](#)

[Lecture 38](#)

[Lecture 39](#)

[Lecture 40](#)

[Lecture 41](#)

[Lecture 42](#)

[Lecture 43](#)

[Lecture 44](#)

[Lecture 45](#)

[Lecture 46](#)

[Lecture 47](#)

[Lecture 48](#)

Lecture 1 - Introduction to Quality Engineering

Lecture 2 - Quality Costs

Lecture 3 - Product Design

Lecture 4 - Design of Experiments

Lecture 5 - Applications of Quality Loss Function

Lecture 6 - Product Selection Strategies

Lecture 7 - Robust Design Approaches

Lecture 8 - Taguchi's Method

Lecture 9 - Failure mode and effects analysis

Lecture 10 - Problem Solving : Failure mode and effects analysis - 1

Lecture 11 - Problem solving : Failure mode and effects analysis - 2

Lecture 12 - Product quality improvement methods

Lecture 13 - Quality tools - Part 1

Lecture 14 - Quality Tools - Part 2

Lecture 15 - Different types of control charts

Lecture 16 - Mean, Variance and Standard deviation

Lecture 17 - X bar chart, R-chart

Lecture 18 - Plotting methods for control charts

Lecture 19 - Six Sigma - Part 1

Lecture 20 - Six Sigma - Part 2

Lecture 21 - Theory of probability

Lecture 22 - Determining the defective products using Probability

Lecture 23 - Sampling based on Permutations and Combinations

Lecture 24 - Binomial distribution

Lecture 25 - Poisson distribution

Lecture 26 - Poisson distribution

Lecture 27 - Normal Distribution

Lecture 28 - Overview of control charts and different types of distribution

Lecture 29 - Fundamental of Robotics and its applications in Automated Systems

Lecture 30 - Joint configuration systems of Robot



Lecture 1 - Introduction to Finite Element Analysis(FEA)

Lecture 2 - Introduction of FEA, Nodes, Elements and Shape Functions

Lecture 3 - Nodes, Elements and Shape Functions

Lecture 4 - Polynomials as Shape Functions, Weighted Residuals, Elements and Assembly Level Equations

Lecture 5 - Types of Errors in FEA, Overall FEA Process and Convergence

Lecture 6 - Strengths of FE Method, Continuity conditions at Interfaces

Lecture 7 - Key concepts and terminologies

Lecture 8 - Weighted integral statements

Lecture 9 - Integration by parts - Review

Lecture 10 - Gradient and Divergence Theorems-Part - I

Lecture 11 - Gradient and Divergence Theorems Part - II

Lecture 12 - Functionals

Lecture 13 - Variational Operator

Lecture 14 - Weighted Integral and Weak Formulation

Lecture 15 - Weak Formulation

Lecture 16 - Weak Formulation and Weighted Integral : Principle of minimum potential energy

Lecture 17 - Variational Methods : Rayleigh Ritz Method

Lecture 18 - Rayleigh Ritz Method

Lecture 19 - Method of Weighted Residuals

Lecture 20 - Different types of Weighted Residual Methods - Part I

Lecture 21 - Different types of Weighted Residual Methods - Part II

Lecture 22 - FEA formulation for 2nd order BVP - Part I

Lecture 23 - FEA formulation for 2nd order BVP - Part II

Lecture 24 - Element Level Equations

Lecture 25 - 2nd Order Boundary Value Problem

Lecture 26 - Assembly of element equations

Lecture 27 - Assembly of element equations and implementation of boundary conditions

Lecture 28 - Assembly process and the connectivity matrix

Lecture 29 - Radially Symmetric Problems

Lecture 30 - One dimensional heat transfer

Lecture 31 - 1D-Heat conduction with convective effects : examples

[Lecture 32 - Euler-Bernoulli beam](#)

[Lecture 33 - Interpolation functions for Euler-Bernoulli beam](#)

[Lecture 34 - Finite element equations for Euler-Bernoulli beam](#)

[Lecture 35 - Assembly equations for Euler-Bernoulli beam](#)

[Lecture 36 - Boundary conditions for Euler-Bernoulli beam](#)

[Lecture 37 - Shear deformable beams](#)

[Lecture 38 - Finite element formulation for shear deformable beams : Part - I](#)

[Lecture 39 - Finite element formulation for shear deformable beams : Part - II](#)

[Lecture 40 - Equal interpolation but reduced integration element](#)

[Lecture 41 - Eigenvalue problems](#)

[Lecture 42 - Eigenvalue problems : examples](#)

[Lecture 43 - Introduction to time dependent problems](#)

[Lecture 44 - Spatial approximation](#)

[Lecture 45 - Temporal approximation for parabolic problems : Part - I](#)

[Lecture 46 - Temporal approximation for parabolic problems : Part - II](#)

[Lecture 47 - Temporal approximation for hyperbolic problems](#)

[Lecture 48 - Explicit and implicit method, diagonalization of mass matrix, closure](#)

Lecture 1 - Introduction

Lecture 2 - Vibration versus Waves

Lecture 3 - Nature of Sound

Lecture 4 - The Decibel Scale

Lecture 5 - Some Key Terms

Lecture 6 - Adding Decibels

Lecture 7 - Modeling Sound Propagation

Lecture 8 - The Momentum Equation

Lecture 9 - The Continuity Equation and The Gas Law

Lecture 10 - 1-D Wave Equation

Lecture 11 - General Solution for 1-D Wave Equation

Lecture 12 - Complex Time Signal and Transfer Functions

Lecture 13 - Transmission line equations

Lecture 14 - Planar Waves in Closed Tubes

Lecture 15 - Planar Waves in 1-D Open Tubes

Lecture 16 - A Semi-Infinite Tube and Overall Summary

Lecture 17 - 1-D Tubes with Imperfect Terminations

Lecture 18 - Measuring Impedance Through Kundt's Apparatus

Lecture 19 - Classification of Microphones

Lecture 20 - Classification of Microphones - Continuation

Lecture 21 - Classification of Microphones by Application

Lecture 22 - Microphone Sensitivity

Lecture 23 - Microphone Sensitivity- Continuation

Lecture 24 - Selecting the Right Microphone

Lecture 25 - Fourier Series Expansion

Lecture 26 - Fourier Series Expansion - Continuation

Lecture 27 - Fourier Integral

Lecture 28 - Fourier Integral - Continuation

Lecture 29 - Fourier Transform

Lecture 30 - Fourier Transform - Continuation

Lecture 31 - Discrete Fourier Transform (DFT)

[Lecture 32 - Discrete Fourier Transform \(DFT\) - Continuation](#)

[Lecture 33 - DFT - Calculating Frequencies and Padding](#)

[Lecture 34 - DFT - Influence of Duration and Sampling frequency on resolution](#)

[Lecture 35 - FFT and Inverse FFT](#)

[Lecture 36 - Considerations while deciding instrumentation](#)

[Lecture 37 - Considerations while selecting instruments for noise measurements](#)

[Lecture 38 - Measuring impedance through two microphone method](#)

[Lecture 39 - Designing an impedance measurement tube](#)

[Lecture 40 - Octave band analysis](#)

[Lecture 41 - Calculating results in octave bands](#)

[Lecture 42 - Weighting](#)

[Lecture 43 - Short time Fourier transforms \(STFT\)](#)

[Lecture 44 - Spectrograms](#)

[Lecture 45 - Reverberation time](#)

[Lecture 46 - Anechoic rooms](#)

[Lecture 47 - STC, NRC and sound attenuation](#)

[Lecture 48 - Reverberant rooms](#)

- Lecture 1 - Introduction to Manufacturing Process Technology
- Lecture 2 - Structure of Matter (Bonding of Solids, Crystal Structures)
- Lecture 3 - Brief introduction of non-conventional machining processes
- Lecture 4 - Structure of matters (bonding of solids, crystal structures)
- Lecture 5 - Elastic and Plastic Deformation
- Lecture 6 - Crystal imperfection and dislocation
- Lecture 7 - Plastic Deformation
- Lecture 8 - Material Properties, Stress Strain Diagram for different types of materials
- Lecture 9 - Friction and Wear, Solid solutions
- Lecture 10 - Equilibrium Phase Diagram
- Lecture 11 - Iron-carbon equilibrium phase diagram
- Lecture 12 - Control of material properties (Alloying and heat treatment), Mechanical properties and Recrystallization
- Lecture 13 - Introduction To Casting Process
- Lecture 14 - Pattern and Mold Design
- Lecture 15 - Mold Making Procedures
- Lecture 16 - Fundamentals of Melting and Furnaces & Pouring and Gating Design
- Lecture 17 - Vertical and Bottom Gating Systems Edit Lesson
- Lecture 18 - Numerical Estimation To Find Mold Filling Time and Mold Design
- Lecture 19 - Effects of friction and velocity distribution in time of filling
- Lecture 20 - Numerical design of gating systems using frictional and bending losses
- Lecture 21 - Principle of cooling and solidification in single and multiphase systems
- Lecture 22 - Estimation of rate of solidification
- Lecture 23 - Principles of cooling and solidification of casting
- Lecture 24 - Modeling of Solidification Rates of Thin Casting in a Metal Mold
- Lecture 25 - Solidification with Predominant Interface Resistance
- Lecture 26 - Solidification with Constant Casting Surface Temperature
- Lecture 27 - Solidification of Casting with Predominant Resistance in Mold and Solidified Metal
- Lecture 28 - Solidification Time for Permanent Mold Casting
- Lecture 29 - Solidification with Constant Casting Surface
- Lecture 30 - Riser Design and Placement - Part 1
- Lecture 31 - Riser Design and Placement - Part 2

[Lecture 32 - Riser Design and Placement - Part 3](#)

[Lecture 33 - Introduction of Machining Processes](#)

[Lecture 34 - Review of Basic Machining Processes and the Mechanics of Chip Formation](#)

[Lecture 35 - Estimation of Cutting Ratio and Shear Angle](#)

[Lecture 36 - Merchant's Force Analysis](#)

[Lecture 37 - Merchant Theory \(Cutting Forces Analysis\)](#)

[Lecture 38 - Merchant Theory \(Force analysis\) Part-2](#)

[Lecture 39 - Lee Shaffer's Solution](#)

[Lecture 40 - Specific Energy Model for Cutting](#)

[Lecture 41 - Modeling of Heat Generation and Cutting Tool Temperature](#)

[Lecture 42 - Temperature in Cutting and Builtup Edge Formation](#)

[Lecture 43 - Metal Cutting Operation](#)

[Lecture 44 - Tool life and Tool wear](#)

[Lecture 45 - Economics of Machining](#)

[Lecture 46 - Joining Process](#)

[Lecture 47 - Principle of Solid State Welding](#)

[Lecture 48 - Numerical Design of Welding Power Sources in Arc Welding](#)

- Lecture 1 - Introduction to Manufacturing Process Technology
- Lecture 2 - Structure of Matter (Bonding of Solids, Crystal Structures)
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- Lecture 11 - Iron-carbon equilibrium phase diagram
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- Lecture 16 - Fundamentals of Melting and Furnaces and Pouring and Gating Design
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- Lecture 18 - Numerical Estimation To Find Mold Filling Time and Mold Design
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- Lecture 26 - Solidification with Constant Casting Surface Temperature
- Lecture 27 - Solidification of Casting with Predominant Resistance in Mold and Solidified Metal
- Lecture 28 - Solidification Time for Permanent Mold Casting
- Lecture 29 - Solidification with Constant Casting Surface
- Lecture 30 - Riser Design and Placement - Part 1
- Lecture 31 - Riser Design and Placement - Part 2

[Lecture 32 - Riser Design and Placement - Part 3](#)

[Lecture 33 - Introduction of Machining Processes](#)

[Lecture 34 - Review of Basic Machining Processes and the Mechanics of Chip Formation](#)

[Lecture 35 - Estimation of Cutting Ratio and Shear Angle](#)

[Lecture 36 - Merchant's Force Analysis](#)

[Lecture 37 - Merchant Theory \(Cutting Forces Analysis\)](#)

[Lecture 38 - Merchant Theory \(Force analysis\) - Part 2](#)

[Lecture 39 - Lee Shaffer's Solution](#)

[Lecture 40 - Specific Energy Model for Cutting](#)

[Lecture 41 - Modeling of Heat Generation and Cutting Tool Temperature](#)

[Lecture 42 - Temperature in Cutting and Builtup Edge Formation](#)

[Lecture 43 - Metal Cutting Operation](#)

[Lecture 44 - Tool life and Tool wear](#)

[Lecture 45 - Economics of Machining](#)

[Lecture 46 - Joining Process](#)

[Lecture 47 - Principle of Solid State Welding](#)

[Lecture 48 - Numerical Design of Welding Power Sources in Arc Welding](#)

[Lecture 49 - Modes of metal transfer in arc welding](#)

[Lecture 50 - Metal forming Processes Edit Lesson](#)

[Lecture 51 - Yield Criterion used in Metal Forming Processes Edit Lesson](#)

[Lecture 52 - Concept of Principal stress, strain](#)

[Lecture 53 - Trescas' Yield criteria and Rolling Process](#)

[Lecture 54 - Rolling Processes - Part 1](#)

[Lecture 55 - Rolling Processes - Part 2](#)

[Lecture 56 - Introduction to Advanced Machining Processes](#)

[Lecture 57 - Classification of Machining Processes](#)

[Lecture 58 - Silicon growth and Crystallography](#)

[Lecture 59 - Micro Fabrication Technology](#)

[Lecture 60 - Photolithography](#)

[Lecture 61 - Soft Lithography](#)

[Lecture 62 - Introduction to Wet Etching Techniques](#)

[Lecture 63 - Introduction to Dry Etching Techniques](#)

[Lecture 64 - Introduction to Abrasive Jet Machining Process](#)



- Lecture 65 - Ultrasonic Machining Process
- Lecture 66 - Determination of MRR of Ultrasonic Machining Process
- Lecture 67 - Mechanics of Ultrasonic Machining (USM)
- Lecture 68 - Effect of Process parameters of USM
- Lecture 69 - Ultrasonic Machining Unit
- Lecture 70 - Introductions of Electro-chemical Drilling Process
- Lecture 71 - Electric Discharge Machining Process
- Lecture 72 - EDM - Part 2
- Lecture 73 - Effect of various process parameters on EDM process
- Lecture 74 - Analysis of RC circuit for EDM
- Lecture 75 - Electrodischarge machining system
- Lecture 76 - Effect of various parameters on EDM Process
- Lecture 77 - Tool Electrodes and Dielectric fluids and Electron Beam Machining
- Lecture 78 - Introduction to Finishing Process
- Lecture 79 - Electrochemical Machining Processes (ECM)
- Lecture 80 - Material Removal Rate of ECM
- Lecture 81 - Electrode Double Layer
- Lecture 82 - Material removal rate of an alloy in ECM
- Lecture 83 - Kinematics and Dynamics of ECM
- Lecture 84 - Temperature and Pressure rise during ECM
- Lecture 85 - Determination of Electrolyte flow velocity in ECM
- Lecture 86 - Theoretical determination of Tool shape
- Lecture 87 - Design for Electrolyte flow in ECM
- Lecture 88 - Mechanics of Electron Beam Machining Process
- Lecture 89 - Functional Characteristics of EBM Process Edit Lesson
- Lecture 90 - Introduction of Laser Beam Machining Process
- Lecture 91 - Material removal rate of LBM
- Lecture 92 - Heat conduction and Temperature rise during LBM
- Lecture 93 - Modelling of LBM processes
- Lecture 94 - Introduction of Additive Techniques
- Lecture 95 - Additive Manufacturing Processes
- Lecture 96 - Fused Deposition Modeling Process

Lecture 1 - History and Evolution of Materials

Lecture 2 - Classification of Materials

Lecture 3 - Advanced and Exotic Materials

Lecture 4 - Mechanical Properties of Materials - I

Lecture 5 - Mechanical Properties of Materials - II

Lecture 6 - Mechanical Properties of Materials - III

Lecture 7 - Bonding between atoms

Lecture 8 - The Role of Crystal Structure - I

Lecture 9 - The Role of Crystal Structure - II

Lecture 10 - The Role of Crystal Structure - III

Lecture 11 - Metals - I (Ferrous alloys)

Lecture 12 - Metals - II (Non-Ferrous alloys)

Lecture 13 - Metals - III (Strengthening and Degradation)

Lecture 14 - Ceramics - I

Lecture 15 - Ceramics - II

Lecture 16 - Polymers : Introduction and Classification

Lecture 17 - Polymeric Structure

Lecture 18 - Effects of Glass transition temperature

Lecture 19 - Polymer Mechanical properties

Lecture 20 - Composites - I

Lecture 21 - Composites - II

Lecture 22 - Composites - III

Lecture 23 - Smart Materials - I (Introduction)

Lecture 24 - Smart Materials - II (Piezoelectricity)

Lecture 25 - Smart Materials - III (Magnetostriction)

Lecture 26 - Smart Materials - IV (Smart Polymers)

Lecture 27 - Smart Materials - V (SMA)

Lecture 28 - Materials Selection in Engineering Design

Lecture 29 - Numerical: Cantilever beam (High stiffness and light weight)

Lecture 30 - Numerical: Cantilever beam (High strength and light weight)

Lecture 31 - Numerical: Connecting rod

[Lecture 32 - Numerical: Probe for scanning probe microscope](#)

[Lecture 33 - Optical Properties](#)

[Lecture 34 - Optical Fiber](#)

[Lecture 35 - Thermal Properties](#)

[Lecture 36 - Numerical: Material selection for Heat exchanger](#)

[Lecture 37 - Electric Properties - I](#)

[Lecture 38 - Electric Properties - II](#)

[Lecture 39 - Magnetic Properties](#)

[Lecture 40 - Laboratory demonstration](#)

Lecture 1 - Introduction to Advanced Machining Processes

Lecture 2 - Classification of Machining Processes

Lecture 3 - Silicon growth and Crystallography

Lecture 4 - Micro Fabrication Technology

Lecture 5 - Photolithography

Lecture 6 - Soft Lithography

Lecture 7 - Introduction to Wet Etching Techniques

Lecture 8 - Introduction to Dry Etching Techniques

Lecture 9 - Introduction of Additive Techniques

Lecture 10 - Introduction to Abrasive Jet Machining Process

Lecture 11 - Ultrasonic Machining Process

Lecture 12 - Determination of MRR of Ultrasonic Machining Process

Lecture 13 - Mechanics of Ultrasonic Machining (USM)

Lecture 14 - Effect of Process parameters of USM

Lecture 15 - Ultrasonic Machining Unit

Lecture 16 - Electrochemical Machining Processes (ECM)

Lecture 17 - Material Removal Rate of ECM

Lecture 18 - Electrode Double Layer

Lecture 19 - Material removal rate of an alloy in ECM

Lecture 20 - Kinematics and Dynamics of ECM

Lecture 21 - Temperature and Pressure rise during ECM

Lecture 22 - Determination of Electrolyte flow velocity in ECM

Lecture 23 - Effect of heat and Hydrogen bubble generation during ECM Process

Lecture 24 - Theoretical determination of Tool shape

Lecture 25 - Design for Electrolyte flow in ECM

Lecture 26 - Introductions of Electro-chemical Drilling Process

Lecture 27 - Introduction to Finishing Process

Lecture 28 - Electric Discharge Machining Process

Lecture 29 - EDM part-2

Lecture 30 - Effect of various process parameters on EDM process

Lecture 31 - Analysis of RC circuit for EDM

- [Lecture 32 - Electrodischarge machining sytem](#)
- [Lecture 33 - Effect of various parameters on EDM Process](#)
- [Lecture 34 - Tool Electrodes and Dielectric fluids and Electron Beam Machining](#)
- [Lecture 35 - Mechanics of Electron Beam Machining Process](#)
- [Lecture 36 - Functional Characteristics of EBM Process Edit Lesson](#)
- [Lecture 37 - Introduction of Laser Beam Machining Process](#)
- [Lecture 38 - Material removal rate of LBM](#)
- [Lecture 39 - Heat conduction and Temperature rise during LBM](#)
- [Lecture 40 - Modelling of LBM processes](#)
- [Lecture 41 - Metal forming Processes Edit Lesson](#)
- [Lecture 42 - Yield Criterion used in Metal Forming Processes Edit Lesson](#)
- [Lecture 43 - Concept of Principal stress, strain](#)
- [Lecture 44 - Trescas' Yield criteria and Rolling Process](#)
- [Lecture 45 - Rolling Processes - Part 1](#)
- [Lecture 46 - Rolling Processes - Part 2](#)
- [Lecture 47 - Additive Manufacturing Processes](#)
- [Lecture 48 - Fused Deposition Modeling Process](#)

Lecture 1 - Overview of the Course

Lecture 2 - Fundamental principles

Lecture 3 - Steps followed in FEA

Lecture 4 - Weak Formulation

Lecture 5 - Weak Formulation : Example Problem

Lecture 6 - Assembling element level equations

Lecture 7 - Errors in FEA Solution

Lecture 8 - Measures of Errors in FEA Solution

Lecture 9 - Convergence and Accuracy of Solution - Part I

Lecture 10 - Convergence and Accuracy of Solution - Part II

Lecture 11 - Convergence - Part I

Lecture 12 - Convergence - Part II

Lecture 13 - Numerical Integration Schemes - Part I

Lecture 14 - Numerical Integration Schemes - Part II

Lecture 15 - Approximations - Part I

Lecture 16 - Approximations - Part II

Lecture 17 - Approximations - Part III

Lecture 18 - Gauss Quadrature

Lecture 19 - Gaussian Quadrature review

Lecture 20 - Gaussian Quadrature - Part II

Lecture 21 - Gaussian Quadrature - Part III

Lecture 22 - Newton-Cotes Quadrature

Lecture 23 - Two dimensional FEM problem

Lecture 24 - Two dimensional one variable FEM problem

Lecture 25 - 2D Finite element problems with single variable (Model equation)

Lecture 26 - 2D Finite element problems with single variable (Weak formulation)

Lecture 27 - Elemental level 2D finite element equations

Lecture 28 - Interpolation functions for 2D finite element problems

Lecture 29 - Interpolation functions for linear triangular elements - Part I

Lecture 30 - Interpolation functions for linear triangular elements - Part II

Lecture 31 - Interpolation functions for Triangular and Rectangular elements

- [Lecture 32 - Evaluation of Stiffness and Force matrices](#)
- [Lecture 33 - Stiffness and Force matrices for Triangular element](#)
- [Lecture 34 - Stiffness and Force matrices for Rectangular element](#)
- [Lecture 35 - Boundary elements for Finite element Equations](#)
- [Lecture 36 - Boundary integrals for Triangular element](#)
- [Lecture 37 - Assembly of 2-D finite elements - Part I](#)
- [Lecture 38 - Assembly of 2-D finite elements - Part II](#)
- [Lecture 39 - 2-D Heat transfer problems - Part I](#)
- [Lecture 40 - 2-D Heat transfer problems - Part II](#)
- [Lecture 41 - Numerical integration schemes for 2-D problems](#)
- [Lecture 42 - Jacobian and transformation matrix for 2-D problems](#)
- [Lecture 43 - Numerical Integration Schemes for 2-D Problems : Closure](#)
- [Lecture 44 - Post-processing](#)
- [Lecture 45 - Plane Elasticity Problems](#)
- [Lecture 46 - Plane Elasticity Problems : Development of Weak form](#)
- [Lecture 47 - Plane Elasticity Problems : Element level equations](#)
- [Lecture 48 - Plane Elasticity Problems : Closure](#)

- Lecture 1 - Introduction to Vibration control
- Lecture 2 - Strategies and Steps in Vibration Control
- Lecture 3 - Strategies, Active control, Detuning and Decoupling
- Lecture 4 - Viscous damping model
- Lecture 5 - Coulomb and Hysteretic damping model
- Lecture 6 - Energy Dissipation in Structural Materials
- Lecture 7 - Material Selection Criterion against Damping
- Lecture 8 - Design for Enhanced Material Damping
- Lecture 9 - Linear Viscoelastic Materials and Models
- Lecture 10 - Maxwell and 3-Parameter Models
- Lecture 11 - Complex modulus and Applications of VEM
- Lecture 12 - Basics of Dynamic Vibration Absorber
- Lecture 13 - Modelling of Dynamic Vibration Absorber
- Lecture 14 - Proof mass Actuator
- Lecture 15 - Springs for Vibration Isolation
- Lecture 16 - Introduction to Active Vibration Control
- Lecture 17 - Basics of Classical Control System
- Lecture 18 - Basics of State Space Control
- Lecture 19 - Controllability and Observability of System
- Lecture 20 - Full State Feedback Control
- Lecture 21 - SMSS Laboratory Demonstration



Lecture 1 - Lesson 1 - Course Overview

Lecture 2 - Lesson 2 - Introduction

Lecture 3 - Lesson 3 - Nature Of Sound

Lecture 4 - Lesson 4 - The Decibel scale

Lecture 5 - Lesson 5 - Key Terms In Acoustics

Lecture 6 - Lesson 6 - Adding Decibels

Lecture 7 - Lesson 1 - Important Mathematical Concepts-Complex Algebra

Lecture 8 - Lesson 2 - Important Mathematical Concepts-Complex Time Signals

Lecture 9 - Lesson 3 - Important Mathematical Concepts-Transfer Function

Lecture 10 - Lesson 4 - Important Mathematical Concepts-Pole Zero Plot

Lecture 11 - Lesson 5 - Important Mathematical Concepts - Bode Plot For Simple Pole

Lecture 12 - Lesson 6 - Important Mathematical Concepts - Bode Plot For Simple Zero

Lecture 13 - Lesson 1 - Bode Plots (Magnitude) for Complex Transfer Functions

Lecture 14 - Lesson 2 - Momentum Equation for 1-D Sound Propagation

Lecture 15 - Lesson 3 - Continuity Equation for 1-D Sound Propagation

Lecture 16 - Lesson 4 - Gas Law for 1-D Sound Propagation

Lecture 17 - Lesson 5 - 1-D Wave Equation

Lecture 18 - Lesson 6 - Solution for 1-D Wave Equation

Lecture 19 - Lesson 1 - Waveguide

Lecture 20 - Lesson 2 - Transmission Line Equations - Part I

Lecture 21 - Lesson 3 - Transmission Line Equations - Part II

Lecture 22 - Lesson 4 - Transmission Line Equations - Part III

Lecture 23 - Lesson 5 - Transmission Line Equations - Part IV

Lecture 24 - Lesson 6 - Transmission Line Equations - Part V

Lecture 25 - Lesson 1 - Instantaneous Power

Lecture 26 - Lesson 2 - Instantaneous Power in a L-R Circuit

Lecture 27 - Lesson 3 - Power Factor, and Acoustic Power

Lecture 28 - Lesson 4 - Power Flow into an Infinitely Long Tube

Lecture 29 - Lesson 5 - Point Sources of Sound

Lecture 30 - Lesson 6 - Relations for Outward Travelling Spherical Acoustic Wave

Lecture 31 - Lesson 1 - Specific Acoustic Impedance for a Closed Tube

[Lecture 32 - Lesson 2 - Specific Acoustic Impedance for an Open Tube and an Infinitely Long Tube](#)

[Lecture 33 - Lesson 3 - Specific Acoustic Impedance for a Tube with Imperfect Termination](#)

[Lecture 34 - Lesson 4 - Kundt's Tube](#)

[Lecture 35 - Lesson 5 - Volume Velocity](#)

[Lecture 36 - Lesson 6 - Comparison of Impedances for a Radially Propagating Wave and a Planar Wave](#)

[Lecture 37 - Lesson 1 - Interference of sound sources - Part I](#)

[Lecture 38 - Lesson 2 - Interference of sound sources - Part II](#)

[Lecture 39 - Lesson 3 - Interference of sound sources - Part III](#)

[Lecture 40 - Lesson 4 - Interference of sound sources - Part IV](#)

[Lecture 41 - Lesson 5 - Directivity](#)

[Lecture 42 - Lesson 6 - Complex power, pressure and velocity for a spherical source](#)

[Lecture 43 - Lesson 1 - Noise reduction - Mass Attenuation Method](#)

[Lecture 44 - Lesson 2 - Noise Reduction - Pressure Ratio](#)

[Lecture 45 - Lesson 3 - Noise Reduction - Velocity of Wall](#)

[Lecture 46 - Lesson 4 - 3 Media Problem - Introduction](#)

[Lecture 47 - Lesson 5 - 3 Media Problem - Apply Boundary Conditions](#)

[Lecture 48 - Lesson 6 - 3 Media Problem - Special cases](#)

[Lecture 49 - Lesson 1 - Mufflers](#)

[Lecture 50 - Lesson 2 - Designing of Reactive Mufflers](#)

[Lecture 51 - Lesson 3 - Designing of Dissipative Mufflers](#)

[Lecture 52 - Lesson 4 - Time and Frequency Domain Representation of a Signal](#)

[Lecture 53 - Lesson 5 - Fourier Series](#)

[Lecture 54 - Lesson 6 - Fourier Series](#)

[Lecture 55 - Lesson 1 - Fourier Transform](#)

[Lecture 56 - Lesson 2 - Fourier Transform](#)

[Lecture 57 - Lesson 3 - Fourier Transform](#)

[Lecture 58 - Lesson 4 - Discrete Fourier Transform \(DFT\)](#)

[Lecture 59 - Lesson 5 - Discrete Fourier Transform \(DFT\)](#)

[Lecture 60 - Lesson 6 - Discrete Fourier Transform \(DFT\)](#)

[Lecture 61 - Lesson 1 - Measuring Sound Signals](#)

[Lecture 62 - Lesson 2 - Microphones](#)

[Lecture 63 - Lesson 3 - Microphones](#)

[Lecture 64 - Lesson 4 - Weighting](#)

[Lecture 65 - Lesson 5 - Loudness](#)

[Lecture 66 - Lesson 6 - Loudness](#)

[Lecture 67 - Lesson 1 - Octave Band Analysis - Part I](#)

[Lecture 68 - Lesson 2 - Octave Band Analysis - Part II](#)

[Lecture 69 - Lesson 3 - Octave Band Analysis - Part III](#)

[Lecture 70 - Lesson 4 - Reverberation Time](#)

[Lecture 71 - Lesson 5 - Calculation of Reverberation Time and Sound Transmission Class \(STC\)](#)

[Lecture 72 - Lesson 6 - Noise Reduction Coefficient \(NRC\)](#)

Lecture 1 - Recap - I

Lecture 2 - Recap - II

Lecture 3 - Recap - III

Lecture 4 - Determination of Phase Diagram (Experimentally) - I

Lecture 5 - Determination of Phase Diagram (Experimentally) - II

Lecture 6 - Determination of Phase Diagram (Thermodynamically)

Lecture 7 - Effect of pressure on phase transformation temperature and concept of equilibrium between condensed and vapor phase

Lecture 8 - Effect of different parameters on heat treatment and concept of saturation vapor pressure with examples

Lecture 9 - Title: Formation of ideal solid or liquid solution and (G-X) diagrams for ideal solutions (Part-I)

Lecture 10 - G-X diagrams (Part- II) and concept of chemical potential (Micro Sign) from G-X diagrams.

Lecture 11 - Concept of common tangent for equilibrium between two phases

Lecture 12 - Expressions for equilibrium of two phases - I

Lecture 13 - Expressions for equilibrium of two phases - II

Lecture 14 - Expressions for equilibrium of two phases - III

Lecture 15 - Determining nucleation of phases using G-X plot

Lecture 16 -  $\hat{\Delta}G$  for nucleation and overall transformation, concepts of solid state transformation including precipitation and Quasi-Chemical Model (QCM)

Lecture 17 - Introduction to real solutions and expression of  $\hat{H}_{mix}$  based on the Quasi-Chemical Model (QCM)

Lecture 18 - Expression for  $\hat{H}_{mix}$  as a function of interaction energy and mole fraction, based on the QCM - Part I

Lecture 19 - Expression for  $\hat{H}_{mix}$  as a function of interaction energy and mole fraction, based on the QCM - Part II

Lecture 20 - Graphical representation of  $\hat{H}_{mix}$ ,  $\hat{G}_{mix}$ , and  $-T\hat{S}_{mix}$  for real solutions and evolution of eutectic phase diagram from the G-X plots

Lecture 21 - Effect of  $\hat{H}_{mix}$  on determination of phase diagrams (same crystal structure)

Lecture 22 - Effect of  $\hat{H}_{mix}$  on determination of phase diagrams (Continued...)

Lecture 23 - Importance of phase diagrams

Lecture 24 - Effect of heat treatment on microstructure evolution in steel - I

Lecture 25 - Effect of heat treatment on microstructure evolution in steel - II

Lecture 26 - Recap of homogeneous and heterogeneous nucleation for solid to solid transformation

Lecture 27 - Nucleation rate and its dependence on T (temp. of interest),  $\hat{I}^*T$ ,  $\hat{I}^*G^*$  and  $\hat{I}^*G^*$  and, introduction to growth kinetics

Lecture 28 - Growth kinetics (Continued...)

Lecture 29 - Growth rate variation with undercooling and kinetics of overall phase transformation

Lecture 30 - Implication of Avrami's equation with example on excel spreadsheet

Lecture 31 - Experimental verification of Avrami Equation

Lecture 32 - Linear regression (least squares) method to find the value of n and k in Avrami equation

Lecture 33 - In this lecture, method to determine the goodness of fit has been explained. Procedure to estimate the values of n and k from experimental data have also been discussed.

Lecture 34 - Stereology and quantitative metallography - I

Lecture 35 - Stereology and quantitative metallography - II

Lecture 36 - Grain size measurements methods

Lecture 37 - Statistical tools for analysis and reporting of obtained data with examples

Lecture 38 - Evolution of TTT and CCT diagram from f vs. t plots

Lecture 39 - TTT, CCT continue and hardenability of steel

Lecture 40 - Importance of heat treatment practices in real life (with examples)

Lecture 1 - Brief Introduction

Lecture 2 - Define Phase, Equilibrium

Lecture 3 - Free Energy, Stability of Phases

Lecture 4 - Gibbs Free Energy of Binary Solution

Lecture 5 - Ideal Solution and Chemical Potential

Lecture 6 - Thermodynamics of solid solutions

Lecture 7 - G vs X curves

Lecture 8 - Solid solutions: Types

Lecture 9 - Heterogeneous phase equilibria

Lecture 10 - G vs X curves for eutectic system

Lecture 11 - G-X plot for peritectic system

Lecture 12 - Effect of temperature of solid solubility, Influence of interfaces on Equilibrium

Lecture 13 - Introduction of Diffusion

Lecture 14 - Mechanism of Diffusion, Fick's I law

Lecture 15 - Fick's II law

Lecture 16 - Fick's II law (Continued...), Diffusion and Temperature

Lecture 17 - Interfacial Free Energy, Solid/Vapor Interface

Lecture 18 - Boundaries in single phase solids

Lecture 19 - High angle grain boundaries, Equilibrium in poly-crystalline materials, Interphase interfaces in solids

Lecture 20 - Interphase interfaces in solids (Continued...)

Lecture 21 - CSL Boundaries

Lecture 22 - Types of Nucleations

Lecture 23 - Homogeneous Nucleation

Lecture 24 - Homogeneous Nucleation (Continued...)

Lecture 25 - Heterogeneous Nucleation

Lecture 26 - Heterogeneous nucleation (Continued...)

Lecture 27 - Growth

Lecture 28 - Atomic mechanism of growth

Lecture 29 - Dendritic Solidification

Lecture 30 - Growth rate for dendrite formation

Lecture 31 - Alloy solidification

- [Lecture 32 - Alloy solidification \(Continued...\)](#)
- [Lecture 33 - Eutectic: Solidification](#)
- [Lecture 34 - Eutectic: solidification \(Continued...\)](#)
- [Lecture 35 - Solidification of casting / ingot](#)
- [Lecture 36 - Precipitation hardenable alloy](#)
- [Lecture 37 - Precipitation age- hardening alloy \(Continued...\)](#)
- [Lecture 38 - Age hardening alloy](#)
- [Lecture 39 - Eutectoid transformation](#)
- [Lecture 40 - Eutectoid transformation \(Continued....\)](#)
- [Lecture 41 - Eutectoid transformation in steel \(Continued...\)](#)
- [Lecture 42 - Martensite](#)
- [Lecture 43 - Martensite \(Continued...\)](#)
- [Lecture 44 - Martensite \(Continued...\) and TTT curves](#)
- [Lecture 45 - TTT diagram](#)
- [Lecture 46 - Recovery, Recrystallization and Grain growth](#)
- [Lecture 47 - Recovery](#)
- [Lecture 48 - Recrystallization](#)
- [Lecture 49 - Recrystallization \(Continued...\)](#)
- [Lecture 50 - Introduction to spinodal decomposition](#)

Lecture 1 - Introduction to Composites

Lecture 2 - Matrices

Lecture 3 - Fiber reinforcements

Lecture 4 - Fiber reinforcements (Continued...)

Lecture 5 - Composites properties

Lecture 6 - Composites testing

Lecture 7 - Selection of material

Lecture 8 - Selection of material (Continued...)

Lecture 9 - Design for Manufacturing

Lecture 10 - Design for Manufacturing (Continued...)

Lecture 11 - Composite Manufacturing Processes

Lecture 12 - Filament winding Processes

Lecture 13 - Resin transfer moulding

Lecture 14 - Pultrusion

Lecture 15 - Compression Moulding Process

Lecture 16 - Vacuum Impregnation Methods

Lecture 17 - Stacking of Composites

Lecture 18 - Thermoplastic Composites Manufacturing Processes - Part 1

Lecture 19 - Thermoplastic Composites Manufacturing Processes - Part 2 (Continued...)

Lecture 20 - Non-destructive testing methods for composite materials

Lecture 21 - Metal Matrix Composites

Lecture 22 - Metal Matrix Composites applications (Continued...)

Lecture 23 - Processing of Metal Matrix Composites - Part 1

Lecture 24 - Processing of Metal Matrix Composites - Part 2

Lecture 25 - Ceramic Matrix Composites

Lecture 26 - Fabrication of Ceramic Matrix Composites (CMCs)

Lecture 27 - Carbon - Carbon Composites

Lecture 28 - Polymer Matrix and Nano Composites

Lecture 29 - Machining of Composites

Lecture 30 - Repair of Composites

Lecture 31 - Manufacturing Processes: Selection and Considerations





[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10](#)

[Lecture 11](#)

[Lecture 12](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

[Lecture 20](#)

[Lecture 21](#)

[Lecture 22](#)

[Lecture 23](#)

[Lecture 24](#)

[Lecture 25](#)

[Lecture 26](#)

[Lecture 27](#)

[Lecture 28](#)

[Lecture 29](#)

[Lecture 30 - Work Systems](#)

[Lecture 31 - Measures of Productivity](#)

[Lecture 32 - Productivity Measurement](#)

[Lecture 33 - Work Study](#)

[Lecture 34 - Motion and time study](#)

[Lecture 35 - Motion Study](#)

[Lecture 36 - Flow Diagram](#)

[Lecture 37 - Time Study](#)

[Lecture 38 - Manual Work System](#)

[Lecture 39 - Worker Machine Systems](#)

[Lecture 40 - Industrial accidents](#)

[Lecture 41 - Human Errors](#)

[Lecture 42 - Workers compensation laws](#)

[Lecture 43 - Organisation Ergonomics - Part 1](#)

[Lecture 44 - Organisation Ergonomics - Part 2](#)

[Lecture 45 - Job Satisfaction](#)

[Lecture 46 - Worker behavior](#)

[Lecture 47 - Job ranking Techniques](#)

[Lecture 48 - Waging System](#)

[Lecture 49 - Biomechanics - 1](#)

[Lecture 50 - Biomechanics - 2](#)

[Lecture 51 - Applications of Biomechanics](#)

[Lecture 52 - Problem solving - 1](#)

[Lecture 53 - Problem solving - 2](#)

[Lecture 54 - Problem solving - 3](#)

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

**NPTEL : NOC:Sustainability through Green Manufacturing Systems - An Applied Approach (Mechanical Engineering)**

**Co-ordinators : Dr. Deepu Philip, Dr. Amandeep Singh**

[Lecture 1 - Basics of Production](#)

[Lecture 2 - Basics of Production \(Continued...\)](#)

[Lecture 3 - Sustainability and Manufacturing](#)

[Lecture 4 - Introduction to Simulation](#)

[Lecture 5 - Introduction to Simulation \(Continued...\)](#)

[Lecture 6 - Basic Statistical Concepts for Sustainable Manufacturing Analysis](#)

[Lecture 7 - Basic Statistical Concepts for Sustainable Manufacturing Analysis \(Continued...\)](#)

[Lecture 8 - Life Cycle Assessment](#)

[Lecture 9 - Life Cycle Assessment Elements](#)

[Lecture 10 - Life Cycle Assessment Procedure](#)

[Lecture 11 - Life Cycle Assessment \(Continued...\)](#)

[Lecture 12 - Sustainability Framework](#)

[Lecture 13 - Basic Modeling Concepts for Factory Simulation](#)

[Lecture 14 - Basic Modeling Concepts for Factory Simulation \(Continued...\)](#)

[Lecture 15 - Green Manufacturing Modelling: Metrics for Green Manufacturing](#)

[Lecture 16 - Green Manufacturing Modelling \(Continued...\) Indices for Green Manufacturing](#)

[Lecture 17 - Green Manufacturing Modelling \(Continued...\) Developing Green Manufacturing System](#)

[Lecture 18 - Productivity and Sustainability](#)

[Lecture 19 - Productivity and Sustainability \(Continued...\)](#)

[Lecture 20 - Green Manufacturing Techniques](#)

[Lecture 21 - Green Manufacturing Techniques \(Continued...\)](#)

[Lecture 22 - Renewable Sources of Energy](#)

[Lecture 23 - Renewable Sources of Energy \(Continued...\)](#)

[Lecture 24 - Renewable energy in India and Industrial Symbiosis](#)

[Lecture 25 - Demonstration of Various Instruments Used for Green Machining](#)

[Lecture 26 - Laboratory demonstration](#)

[Lecture 27 - Developing a Smart Factory](#)

[Lecture 28 - Demonstration on PLM Software](#)

[Lecture 29 - Developing a Smart Factory \(Continued...\)](#)

[Lecture 30 - Sustainability and Green Manufacturing System](#)

Lecture 1 - Course Overview

Lecture 2 - Introduction

Lecture 3 - Nature Of Sound

Lecture 4 - Beats

Lecture 5 - The Decibel Scale

Lecture 6 - Key Terms in Acoustics

Lecture 7 - Decibel Scale - Part 1

Lecture 8 - Decibel Scale - Part 2

Lecture 9 - Decibel Scale - Part 3

Lecture 10 - Complex Numbers

Lecture 11 - Complex Time Function

Lecture 12 - Linear Systems

Lecture 13 - Transfer Functions

Lecture 14 - Introduction to One Dimensional Wave Equation

Lecture 15 - The Momentum Equation

Lecture 16 - The Continuity Equation and The Gas Law

Lecture 17 - One Dimensional Wave Equation

Lecture 18 - Solution for One Dimensional Wave Equation

Lecture 19 - Transmission Line Equations

Lecture 20 - One Dimensional Example Problems

Lecture 21 - Impedance

Lecture 22 - Pressure Wave Travels in a Closed Tube

Lecture 23 - Standing Wave Formation in a Closed Tube With Rigid Termination

Lecture 24 - Pressure Wave Travels in an Open Tube

Lecture 25 - 1-D sound wave propagation: Kundt's tube - I

Lecture 26 - 1-D sound wave propagation: Kundt's tube - II

Lecture 27 - Radially propagating sound waves in spherical coordinate system - I

Lecture 28 - Radially propagating sound waves in spherical coordinate system - II

Lecture 29 - Complex impedance for radially propagating sound waves in spherical coordinate system

Lecture 30 - Volume velocity - I

Lecture 31 - Interference of 1-D spherically propagating sound waves - I

- Lecture 32 - Interference of 1-D spherically propagating sound waves - II
- Lecture 33 - Noise sources and introduction to microphones
- Lecture 34 - Classification of microphones - I
- Lecture 35 - Classification of microphones - II
- Lecture 36 - Classification of microphones - III
- Lecture 37 - Microphone Parameters
- Lecture 38 - Understanding microphone specifications
- Lecture 39 - Noise Source: Terminology
- Lecture 40 - Noise Source: Sound Attenuation
- Lecture 41 - Noise Source: Sound Pressure Level due to a noise source located outdoors
- Lecture 42 - Noise Source: Role of reflecting surfaces
- Lecture 43 - Noise Source: Sound Pressure Level due to a noise source located indoors - Part I
- Lecture 44 - Noise Source: Sound Pressure Level due to a noise source located indoors - Part II
- Lecture 45 - Measuring Sound Power Level - Understanding standard octave bands
- Lecture 46 - Measuring Sound Power Level - Fan noise - Part I
- Lecture 47 - Measuring Sound Power Level - Fan noise - Part II
- Lecture 48 - Measuring Sound Power Level - Fan noise - Part III
- Lecture 49 - Weighting
- Lecture 50 - Noise coming from Motors
- Lecture 51 - Noise coming from Motors and Pumps
- Lecture 52 - Noise coming from Pump and Motor Working Simultaneously
- Lecture 53 - Noise coming from Compressors
- Lecture 54 - Example problems regarding Noise coming from Compressor
- Lecture 55 - Noise Spread Mechanisms
- Lecture 56 - Reverberation time
- Lecture 57 - Reverberation time example problem
- Lecture 58 - Noise from Adjacent Room
- Lecture 59 - Acoustic Enclosures
- Lecture 60 - Acoustic Enclosures - Example Problems
- Lecture 61 - Large acoustical enclosures - I
- Lecture 62 - Large acoustical enclosures - II
- Lecture 63 - Acoustic barriers - I
- Lecture 64 - Acoustic barriers - II

[Lecture 65 - Acoustic barriers - III](#)

[Lecture 66 - Helmholtz resonator - I](#)

[Lecture 67 - Silencers](#)

[Lecture 68 - Side Branched Mufflers - I](#)

[Lecture 69 - Side Branched Mufflers - II](#)

[Lecture 70 - Side Branched Mufflers - III](#)

[Lecture 71 - Expansion Chamber Muffler](#)

[Lecture 72 - Single Expansion Chamber Muffler](#)

**NPTEL : NOC:Design Practice (Mechanical Engineering)**

**Co-ordinators : Dr. Shantanu Bhattacharya**

Lecture 1 - Brief introduction of Design systems

Lecture 2 - Product Development

Lecture 3 - Basic protocols of industrial design

Lecture 4 - Design thinking and innovation

Lecture 5 - Brain Storming

Lecture 6 - Design prototyping

Lecture 7 - Generic Phases of the Design

Lecture 8 - Configurational Design Aspects

Lecture 9 - Concurrent Engineering

Lecture 10 - Concurrent Engineering - 2

Lecture 11 - Concurrent Engineering Approaches

Lecture 12 - Concurrent Engineering Approaches - 2

Lecture 13 - Benefits of concurrent engineering

Lecture 14 - Concurrent engineering environment influencing dimensions

Lecture 15 - Concurrent engineering environment influencing dimensions - 2

Lecture 16 - Program and product Interface dimensions in Concurrent engineering

Lecture 17 - Product Development Methodology

Lecture 18 - Elements of concurrent engineering: Optimization in product development

Lecture 19 - Business relationships in concurrent engineering

Lecture 20 - Organizational elements in concurrent engineering

Lecture 21 - Techniques for the Implementation of concurrent engineering environment

Lecture 22 - Average quality loss

Lecture 23 - Robustness in Design

Lecture 24 - Robustness in Design - 2

Lecture 25 - Material selection in Engineering design

Lecture 26 - Material selection in Engineering Design.

Lecture 27 - Basic steps in Material Selection Process

Lecture 28 - Design of Work Systems

Lecture 29 - Motion Study

Lecture 30 - Axiomatic Design

Lecture 31 - Introduction to group technology





Lecture 1 - Definition of the composite materials

Lecture 2 - Composite materials and its applications

Lecture 3 - Classification of the composite materials

Lecture 4 - What Makes fiber so strong?

Lecture 5 - Advantages and limitations of composite materials

Lecture 6 - Properties of the composite materials.

Lecture 7 - Different Types of Fiber

Lecture 8 - Production process and different types of Glass Fiber

Lecture 9 - Graphite Fibers

Lecture 10 - Aramid and Boron Fibers

Lecture 11 - Ceramic Fibers

Lecture 12 - Matrix - Properties and classifications

Lecture 13 - Polymers as matrix material and its classification

Lecture 14 - Thermosets and thermoplastics

Lecture 15 - Properties of thermosets and thermoplastics

Lecture 16 - Thermoset materials and its production methods

Lecture 17 - Thermoplastics and metals as matrix materials

Lecture 18 - Ceramic and carbon matrices

Lecture 19 - What is a good fabrication process of a composite?

Lecture 20 - Fabrication of Thermoset Composites

Lecture 21 - Hand Lay-Up Process

Lecture 22 - Bag Molding Process

Lecture 23 - Resin Transfer Molding Process

Lecture 24 - Fabrication of Thermoplastic, Metal and Ceramic Matrix based Composites

Lecture 25 - Terminologies and basic concepts

Lecture 26 - Orthotropic material

Lecture 27 - Modeling of unidirectional composites

Lecture 28 - Composite density as a function of mass fraction and volume fraction

Lecture 29 - Calculation of longitudinal modulus for unidirectional composites

Lecture 30 - Failure modes of unidirectional composite

Lecture 31 - Failure of Unidirectional Lamina

- Lecture 32 - Minimum Volume Fraction and Critical Volume Fraction
- Lecture 33 - Example based on Failure of Composite Material
- Lecture 34 - Example based on Minimum and Critical Volume Fraction
- Lecture 35 - Transverse Modulus of Unidirectional Composite
- Lecture 36 - Halpin-Tsai Relation for Transverse Modulus
- Lecture 37 - Transverse modulus of unidirectional composites
- Lecture 38 - Transverse strength of unidirectional composites
- Lecture 39 - Poisson's ratio of unidirectional composites
- Lecture 40 - Failure modes of composite materials
- Lecture 41 - Failure modes of composite materials
- Lecture 42 - Other properties
- Lecture 43 - Concept of Tensor
- Lecture 44 - Stress Transformation (Two Dimensional)
- Lecture 45 - Analysis of Specially Orthotropic Lamina
- Lecture 46 - Analysis of Generally Orthotropic Lamina
- Lecture 47 - Transformation of Engineering Constants - Part I
- Lecture 48 - Transformation of Engineering Constants - Part II
- Lecture 49 - Variation of elastic constants with respect to fiber orientation for generally orthotropic lamina
- Lecture 50 - Generally orthotropic lamina
- Lecture 51 - Generalized Hooke's law for anisotropic materials
- Lecture 52 - Generalized Hooke's law for anisotropic materials
- Lecture 53 - Elastic constants for Specially orthotropic materials
- Lecture 54 - Elastic constants for Specially orthotropic materials in plane stress
- Lecture 55 - Relation Between Engineering Constants and Elements of Stiffness and Compliance Matrices - Part I
- Lecture 56 - Relation Between Engineering Constants and Elements of Stiffness and Compliance Matrices - Part II
- Lecture 57 - Stress Strain Relations for A Lamina With Arbitrary Orientation - Part I
- Lecture 58 - Stress- Strain Relation for A Lamina With Arbitrary Orientation - Part II
- Lecture 59 - Strength of An Orthotropic Lamina
- Lecture 60 - Importance of Sign of Shear Stress in context of Strength of A Unidirectional Lamina
- Lecture 61 - Strain displacement relations for a laminate
- Lecture 62 - Stress-strain relations for individual layers of a laminate
- Lecture 63 - Resultant forces and moments
- Lecture 64 - Relations between force and moment resultants and mid-plane strains and curvatures

[Lecture 65 - Physical significance of extensional stiffness matrix \[A\], coupling matrix \[B\] and bending stiffness matrix \[D\] matrices](#)

[Lecture 66 - Lamination sequence \(standard laminate code\)](#)

[Lecture 67 - Calculation of A, B and D Matrices.](#)

[Lecture 68 - Simplification of Stiffness Matrices - Part I](#)

[Lecture 69 - Simplification of Stiffness Matrices - Part II](#)

[Lecture 70 - Quasi-Isotropic Laminates - Part I](#)

[Lecture 71 - Quasi-Isotropic Laminates - Part II](#)

[Lecture 72 - Failure of Composite Laminates](#)

Lecture 1 - Introduction to product design and Manufacturing

Lecture 2 - Introduction to product design and Manufacturing (Continued...)

Lecture 3 - Fundamentals of Manufacturing towards Product Development

Lecture 4 - Fundamentals of Manufacturing towards Product Development (Continued...)

Lecture 5 - Engineering Design Process

Lecture 6 - Product design morphology

Lecture 7 - Product characteristics

Lecture 8 - Elements of Visual Design - Part 1

Lecture 9 - Elements of Visual Design - Part 2

Lecture 10 - Elements of Visual Design - Part 3

Lecture 11 - Translating Customer Needs

Lecture 12 - Translating Customer Needs

Lecture 13 - Value Engineering, an introduction

Lecture 14 - Value Engineering Methodology - Part 1

Lecture 15 - Value Engineering Methodology - Part 2, FAST diagramming

Lecture 16 - Value Engineering Methodology - Part 3

Lecture 17 - Value Engineering, case study

Lecture 18 - Materials Selection - Part 1

Lecture 19 - Materials Selection - Part 2

Lecture 20 - Manufacturing Process Selection - Part 1

Lecture 21 - Manufacturing Process Selection - Part 2

Lecture 22 - Product Costing

Lecture 23 - Design for Manufacturing

Lecture 24 - Design for Assembly

Lecture 25 - Design for Maintenance

Lecture 26 - Design for Environment - Part 1

Lecture 27 - Design for Environment - Part 2

Lecture 28 - Quality Control

Lecture 29 - Quality Assurance

Lecture 30 - Patent - Part 1

Lecture 31 - Patent - Part 2

[Lecture 32 - Creativity techniques - Part 1](#)

[Lecture 33 - Creativity techniques - Part 2](#)

[Lecture 34 - Frugal Innovation](#)

[Lecture 35 - Rapid Prototyping, an introduction](#)

[Lecture 36 - Rapid Prototyping Modelling](#)

[Lecture 37 - Rapid Prototyping Processes - Part 1](#)

[Lecture 38 - Rapid Prototyping Processes - Part 2](#)

[Lecture 39 - Laboratory demonstration; 3D printing - Part 1](#)

[Lecture 40 - Laboratory demonstration; 3D printing - Part 2](#)

[Lecture 41 - Laboratory demonstration; 3D printing - Part 3](#)

[Lecture 42 - Plant Layout Planning - Part 1](#)

[Lecture 43 - Plant Layout Planning - Part 2](#)

[Lecture 44 - Laboratory demonstration; Plant Simulation - Part 1](#)

[Lecture 45 - Laboratory demonstration; Plant Simulation - Part 2](#)

[Lecture 46 - Laboratory demonstration; Plant Simulation - Part 3](#)

[Lecture 47 - Computer Integrated Manufacturing - Part 1](#)

[Lecture 48 - Computer Integrated Manufacturing - Part 2](#)

[Lecture 49 - Reverse Engineering](#)

[Lecture 50 - Managing Competitiveness](#)

Lecture 1 - Basic Thermodynamics: System, phase and components

Lecture 2 - Basic Thermodynamics: Gibbs Free Energy

Lecture 3 - Phase Stability in Materials

Lecture 4 - Effects of Temperature and Pressure on Single Components System

Lecture 5 - Clausius-Clapeyron Equation and Binary Solution

Lecture 6 - Calculation of Configurational Entropy

Lecture 7 - Chemical Potential

Lecture 8 - Phase Stability in Binary Solution

Lecture 9 - Activity and Thermodynamics of Regular Solution

Lecture 10 - Thermodynamic of Real Solution

Lecture 11 - Free Energy Curves and Various Systems

Lecture 12 - Solubility Limits 2-phase Co-existence

Lecture 13 - Phase Diagram Formation: Binary Solution

Lecture 14 - Phase Diagram Construction: Partial Soluble Phases

Lecture 15 - Phase Diagram Construction: Eutectic Phase

Lecture 16 - Intermetallics and Phase Diagrams

Lecture 17 - Phase Rule

Lecture 18 - Gibb's Phase Rule: Unary and Binary System

Lecture 19 - Gibb's Phase Rule: Eutectic Point and Lever Rule

Lecture 20 - Phase Fraction Calculation in a Phase Diagram

Lecture 21 - Microstructure evolution in Cu-Ni binary system

Lecture 22 - Microstructure evolution (Continued...)

Lecture 23 - Phase evolution in hypoeutectic region

Lecture 24 - Phase evolution at Eutectic point

Lecture 25 - Phase Diagrams of Cu-Ni and Al-Si

Lecture 26 - Phase Diagrams of Pb-Sn and Fe-C

Lecture 27 - Phase Diagram of Fe-C (Continued...)

Lecture 28 - Fe-C Phase Diagram (Continued...)

Lecture 29 - Fe-C Phase Diagram (Continued...)

Lecture 30 - Phase Diagrams for non-Ferrous Alloys

Lecture 31 - Method of measuring Phase diagram

[Lecture 32 - Methods of measuring phase diagram \(Continued...\)](#)

[Lecture 33 - Methods of measuring phase diagram: PbMg<sub>2</sub>](#)

[Lecture 34 - Ternary Phase Diagram](#)

[Lecture 35 - Ternary Phase Diagram \(Continued...\)](#)

[Lecture 36 - Ternary system with two phases](#)

[Lecture 37 - Ternary system with three phases](#)

[Lecture 38 - Ternary phase diagram with 4 phases](#)

[Lecture 39 - Application of Phases diagrams](#)

[Lecture 40 - Summary of Course](#)



Lecture 1 - Basics of composite materials

Lecture 2 - Different type of Fibers

Lecture 3 - Properties of single layer continuous fiber composites

Lecture 4 - Properties of single layer continuous fiber composites

Lecture 5 - Strength of single layer continuous fiber composites

Lecture 6 - Strength of single layer continuous fiber composites

Lecture 7 - Concept of Tensor

Lecture 8 - General Anisotropic Material

Lecture 9 - Specially Orthotropic Material

Lecture 10 - Specially Orthotropic Material Under Plane Stress

Lecture 11 - Stress and Strain Transformation

Lecture 12 - Transformation of Stiffness and Compliance Matrices

Lecture 13 - Strain - Displacement relations

Lecture 14 - Relations for stress and strain along thickness of laminate

Lecture 15 - Stress - Strain variation along Laminate thickness

Lecture 16 - Force and Moment resultant - Part 1

Lecture 17 - Force and Moment resultant - Part 2

Lecture 18 - Important observation related to [A], [B] and [D] matrices

Lecture 19 - Quasi-Isotropic Laminates

Lecture 20 - Maximum Stress Theory

Lecture 21 - Maximum Strain Theory

Lecture 22 - Importance of Sign of Shear Stress.

Lecture 23 - Failure Initiation in Composite Laminate.

Lecture 24 - Progressive Failure of Laminae in A Laminate

Lecture 25 - Governing equations for composite plates

Lecture 26 - Force equilibrium in Z-direction

Lecture 27 - Moment equilibrium equations

Lecture 28 - Equilibrium equations for composite plates

Lecture 29 - Boundary conditions associated with different edges of composite plate - Part 1

Lecture 30 - Boundary conditions associated with different edges of composite plate - Part 2

Lecture 31 - Generalized Solution for Semi-Infinite Plate - Part I

- Lecture 32 - Generalized Solution for Semi-Infinite Plate - Part II
- Lecture 33 - Particular Solution for Semi-Infinite Plate: Case A
- Lecture 34 - Particular Solution for Semi-Infinite Plate: Case B
- Lecture 35 - Particular Solution for Semi-Infinite Plate: Case C
- Lecture 36 - Particular Solution for Semi-Infinite Plate: Case D
- Lecture 37 - Solution for governing equation related to semi-infinite composite plate
- Lecture 38 - Nature of displacement  $u_0(x)$  and how it gets influence by important parameters of lamination sequence
- Lecture 39 - Semi-infinite plate loaded in the x-direction - Part 1
- Lecture 40 - Semi-infinite plate loaded in the x-direction - Part 2
- Lecture 41 - Thermal effects in composite laminates - Part 1
- Lecture 42 - Thermal effects in composite laminates - Part 2
- Lecture 43 - Thermal effects in composite laminates - Part 3
- Lecture 44 - Finite Rectangular Plate
- Lecture 45 - Different Boundary Conditions in Finite Rectangular Plate
- Lecture 46 - Example Based On a Finite Rectangular Plate: Part-I
- Lecture 47 - Example Based On a Finite Rectangular Plate: Part-II
- Lecture 48 - Example Based On a Finite Rectangular Plate: Part-III
- Lecture 49 - Anticlastic curvature
- Lecture 50 - Principle of virtual work
- Lecture 51 - Virtual work method: apply to beam problem
- Lecture 52 - Virtual work method: apply to simply supported plate
- Lecture 53 - Beam (two term solution)
- Lecture 54 - 3rd Interpretation of special Galerkin method
- Lecture 55 - Role of D16 and D26 Terms On Laminated Plate Response: Part-I
- Lecture 56 - Role of D16 and D26 Terms On Laminated Plate Response: Part-II
- Lecture 57 - Role of D16 and D26 Terms On Laminated Plate Response: Part-III
- Lecture 58 - Role of D16 and D26 Terms On Laminated Plate Response: Part-IV
- Lecture 59 - Free Vibration in Composite Plate: Part-I
- Lecture 60 - Free Vibration in Composite Plate: Part-II
- Lecture 61 - Buckling of composite plates
- Lecture 62 - Force equilibrium in z-direction for buckling of composite plates
- Lecture 63 - Moment equilibrium around x, y and z-directions for buckling of composite plates
- Lecture 64 - Buckling of an infinitely long composite plate

[Lecture 65 - Buckling of a simply supported finite plate](#)

[Lecture 66 - Composite plate under bidirectional compression](#)

[Lecture 67 - Shear Buckling in Rectangular Composite Plate: Part-I](#)

[Lecture 68 - Shear Buckling in Rectangular Composite Plate: Part-II](#)

[Lecture 69 - Introduction to Short-Fiber Composites](#)

[Lecture 70 - Theories of Stress Transfer: Part-I](#)

[Lecture 71 - Theories of Stress Transfer: Part-II](#)

[Lecture 72 - Modulus of Short-Fiber Composites and Closure](#)

Lecture 1 - Introduction to measurements and metrology

Lecture 2 - Instruments in measurement systems

Lecture 3 - Instruments in measurement systems

Lecture 4 - General concepts and definitions in metrology

Lecture 5 - Standards of measurement

Lecture 6 - Limits, Fits, and Tolerances - Part 1

Lecture 7 - Limits, Fits, and Tolerances - Part 2

Lecture 8 - Limits, Fits, and Tolerances - Part 3

Lecture 9 - Limits, Fits, and Tolerances - Part 4

Lecture 10 - Linear Measurements - Part 1

Lecture 11 - Linear Measurements - Part 2

Lecture 12 - Laboratory demonstration, Vernier Caliper

Lecture 13 - Laboratory demonstration, Dial gauge and vernier, micrometer, surface plate, feeler gauge

Lecture 14 - Angular Measurements - Part 1

Lecture 15 - Angular Measurements - Part 2

Lecture 16 - Laboratory demonstration, Vernier height gauge

Lecture 17 - Laboratory demonstration, Thread gauge, spirit level

Lecture 18 - Laboratory demonstration, Combination set, slip gauges, sine bar

Lecture 19 - Comparators - Part 1

Lecture 20 - Comparators - Part 2

Lecture 21 - Transducers - Part 1

Lecture 22 - Transducers - Part 2

Lecture 23 - Screw thread metrology

Lecture 24 - Gears metrology - Part 1

Lecture 25 - Gears metrology - Part 2

Lecture 26 - Laboratory demonstration, Gear Vernier

Lecture 27 - Surface metrology

Lecture 28 - Temperature measurements

Lecture 29 - Pressure measurements - Part 1

Lecture 30 - Pressure measurements - Part 2

Lecture 31 - Strain measurements - Part 1

- Lecture 32 - Strain measurements - Part 2
- Lecture 33 - Optical measurements and Nanometrology - Part 1
- Lecture 34 - Optical measurements and Nanometrology - Part 2
- Lecture 35 - Optical measurements and Nanometrology - Part 3
- Lecture 36 - Statistics in Metrology, an introduction - Part 1
- Lecture 37 - Statistics in Metrology, an introduction - Part 2
- Lecture 38 - Data and scales in measurements
- Lecture 39 - Discrete and continuous data
- Lecture 40 - Statistics for metrology, fundamental concepts - Part 1
- Lecture 41 - Statistics for metrology, fundamental concepts - Part 2
- Lecture 42 - Statistics for metrology, fundamental concepts - Part 3
- Lecture 43 - Probability distributions for estimating measurement
- Lecture 44 - Normal distribution
- Lecture 45 - Statistics for proportions
- Lecture 46 - Chi square distribution, and Data outlier detection
- Lecture 47 - Quality Control, introduction
- Lecture 48 - Quality Control, control charts for variables
- Lecture 49 - Quality Control, control charts for attributes
- Lecture 50 - Quality Control, critical aspects
- Lecture 51 - 3D measurements, Coordinate Measuring Machine (CMM)
- Lecture 52 - Laboratory demonstration, Coordinate Measuring Machine (CMM)

Lecture 1 - Introduction to Smart Materials

Lecture 2 - Piezoelectric Material

Lecture 3 - Magnetostrictive Material

Lecture 4 - Active Smart Polymer

Lecture 5 - Shape Memory Alloys

Lecture 6 - Introduction to composites

Lecture 7 - Classification of Composites

Lecture 8 - Micromechanics and Macromechanics of Composites

Lecture 9 - Classical Laminated Plate Theory

Lecture 10 - ABD Matrices

Lecture 11 - Modelling of piezoelectric material 1

Lecture 12 - Modelling of piezoelectric material 2

Lecture 13 - Modelling of Magnetostrictive material

Lecture 14 - Modelling of Shape memory Alloys

Lecture 15 - Smart Actuators

Lecture 16 - Smart Materials based MEMS

Lecture 17 - Smart MEMS Applications

Lecture 18 - Energy Harvesting

Lecture 19 - Concept of Self Healing

Lecture 1 - Design concepts

Lecture 2 - Computer Aided Design (CAD)

Lecture 3 - Geometrical transformation

Lecture 4 - Composition of geometrical transformation

Lecture 5 - Geometric modeling

Lecture 6 - Representation of curves

Lecture 7 - Parametric representation of synthetic curves

Lecture 8 - Curve fitting problem (Hermite case)

Lecture 9 - Problem solving (based on Bezier curve)

Lecture 10 - Representation of Surfaces

Lecture 11 - Introduction to Micro-Electro mechanical Systems (MEMS)

Lecture 12 - Lab-on-Chip

Lecture 13 - Introduction to Sensors

Lecture 14 - Introduction to Transducers

Lecture 15 - Introduction to device fabrications

Lecture 16 - Introduction to Silicon as a MEMS material

Lecture 17 - Etching processes

Lecture 18 - Types of Photolithography

Lecture 19 - Introduction to actuators

Lecture 20 - Designing of the Micro-Valve

Lecture 21 - Electrochemical valves

Lecture 22 - Micropumps

Lecture 23 - Designing of peristaltic pumps

Lecture 24 - Different types of pumps and sensors

Lecture 25 - Gas Sensors

Lecture 26 - Computer Numerical Control

Lecture 27 - Numerical Control Programming

Lecture 28 - NC Part Programming

Lecture 29 - Canned Cycles

Lecture 30 - Introduction to Rapid Prototyping

Lecture 31 - Different Types of Rapid Prototyping Technologies

[Lecture 32 - LAB Demonstration of FDM Process](#)

[Lecture 33 & 34](#)

[Lecture 35](#)

[Lecture 36](#)

[Lecture 37, 38 & 39](#)

[Lecture 40](#)



- Lecture 1 - Introduction to Rapid Manufacturing - Part 1
- Lecture 2 - Introduction to Rapid Manufacturing - Part 2
- Lecture 3 - Introduction to Rapid Manufacturing - Part 3
- Lecture 4 - Product Development Process - Part 1
- Lecture 5 - Product Development Process - Part 2
- Lecture 6 - Product Development Process - Part 3
- Lecture 7 - Design for Modularity (Manufacturing)
- Lecture 8 - Design for Modularity (Assembly; Part 1)
- Lecture 9 - Design for Modularity (Assembly; Part 2)
- Lecture 10 - Design for Modularity
- Lecture 11 - Subtractive versus Rapid Manufacturing
- Lecture 12 - Reverse Engineering - Part 1
- Lecture 13 - Reverse Engineering - Part 2
- Lecture 14 - Laboratory Demonstration, Co-ordinate Measuring Machine - Part 1
- Lecture 15 - Laboratory Demonstration, Co-ordinate Measuring Machine - Part 2
- Lecture 16 - Laboratory Demonstration, 3D scanners - Part 1
- Lecture 17 - Laboratory Demonstration, 3D scanners - Part 2
- Lecture 18 - Polymerization Processes - Part 1
- Lecture 19 - Polymerization Processes - Part 2
- Lecture 20 - Powder based processes - Part 1
- Lecture 21 - Powder based processes - Part 2
- Lecture 22 - Powder based processes - Part 3
- Lecture 23 - Extrusion based processes - Part 1
- Lecture 24 - Extrusion based processes - Part 2
- Lecture 25 - Sheet Stacking processes
- Lecture 26 - 3D printing processes
- Lecture 27 - Laboratory Demonstration, 3D printing - Part 1
- Lecture 28 - Laboratory Demonstration, 3D printing - Part 2
- Lecture 29 - Laboratory Demonstration, 3D printing - Part 3
- Lecture 30 - Beam Deposition processes
- Lecture 31 - Materials in Rapid Manufacturing - Part 1

[Lecture 32 - Materials in Rapid Manufacturing - Part 2](#)

[Lecture 33 - Post-processing concerns - Part 1](#)

[Lecture 34 - Post-processing concerns - Part 2](#)

[Lecture 35 - Product costing for Rapid Manufacturing - Part 1](#)

[Lecture 36 - Product costing for Rapid Manufacturing - Part 2](#)

[Lecture 37 - Rapid Product Development, CAD/CAM - Part 1](#)

[Lecture 38 - Rapid Product Development, CAD/CAM - Part 2](#)

[Lecture 39 - Rapid Product Development, CAD/CAM - Part 3](#)

[Lecture 40 - Rapid Product Development, CAE and CIM](#)

[Lecture 41 - Rapid Product Development, Technomatix, Plant Simulation 10 - Part 1](#)

[Lecture 42 - Rapid Product Development, Technomatix, Plant Simulation 10 - Part 2](#)

[Lecture 43 - Rapid Product Development, Technomatix, Plant Simulation 10 - Part 3](#)

[Lecture 44 - Rapid Manufacturing, case studies](#)

Lecture 1 - Introduction to Combustion

Lecture 2 - Introduction to Combustion (Continued...)

Lecture 3 - Introduction to Combustion (Continued...)

Lecture 4 - Introduction to Combustion (Continued...) + Combustion and Thermochemistry

Lecture 5 - Combustion and Thermochemistry

Lecture 6 - Combustion and Thermochemistry (Continued...)

Lecture 7 - Combustion and Thermochemistry (Continued...) + Chemical Kinetics

Lecture 8 - Chemical Kinetics (Continued...)

Lecture 9 - Chemical Kinetics (Continued...)

Lecture 10 - Chemical Kinetics (Continued...) + Combustion Chemistry

Lecture 11 - Combustion Chemistry (Continued...)

Lecture 12 - Heat and Mass Transfer

Lecture 13 - Heat and Mass Transfer + Coupling of Chemical Kinetics and Thermodynamics

Lecture 14 - Coupling of Chemical Kinetics and Thermodynamics (Continued...)

Lecture 15 - Coupling of Chemical Kinetics and Thermodynamics + Laminar Premixed Flames

Lecture 16 - Laminar Premixed Flames (Continued...)

Lecture 17 - Laminar Premixed Flames (Continued...)

Lecture 18 - Laminar Premixed Flames (Continued...) + Laminar Non-Premixed Flames

Lecture 19 - Laminar Non-Premixed Flames (Continued...)

Lecture 20 - Laminar Non-Premixed Flames (Continued...)

Lecture 21 - Laminar Non-Premixed Flames

Lecture 22 - Laminar Non-Premixed Flames (Continued...)

Lecture 23 - Laminar Non-Premixed Flames (Continued...)

Lecture 24 - Laminar Non-Premixed Flames (Continued...)

Lecture 25 - Laminar Non-Premixed Flames (Continued...)

Lecture 26 - Laminar Non-Premixed Flames + Turbulence

Lecture 27 - Turbulence : Introduction

Lecture 28 - Turbulence : Introduction (Continued...)

Lecture 29 - Turbulence : Flow Stability analysis

Lecture 30 - Turbulence : Flow Stability analysis (Continued...)

Lecture 31 - Turbulence : Stability and Burger's Equation

- Lecture 32 - Turbulence : Energy cascade, length scales and Statistical description
- Lecture 33 - Turbulence : Statistical analysis and free shear flows
- Lecture 34 - Turbulence : Free shear and wall bounded shear flows
- Lecture 35 - Turbulence : Turbulent boundary layer
- Lecture 36 - Turbulence
- Lecture 37 - Turbulence : Temperature effects and Modelling
- Lecture 38 - Turbulence : Modelling and statistics
- Lecture 39 - Turbulence : Modelling (Continued...)
- Lecture 40 - Turbulence : Modelling (Continued...)
- Lecture 41 - Turbulence : Chemistry Interaction
- Lecture 42 - Turbulence : Chemistry Interaction (Continued...)
- Lecture 43 - Turbulence : Chemistry Interaction (Continued...)
- Lecture 44 - Turbulence : Chemistry Interaction (Continued...)
- Lecture 45 - Turbulence : Chemistry Interaction (Continued...)
- Lecture 46 - Turbulent Combustion : Stochastic method of solution
- Lecture 47 - Turbulent Combustion : Transported scalar PDF model
- Lecture 48 - Turbulent Combustion : Transported joint velocity - scalar PDF model
- Lecture 49 - Turbulent Combustion : Modelling Turbulent Premixed Combustion
- Lecture 50 - Turbulent Combustion : Modelling Turbulent Premixed Combustion (Continued...)
- Lecture 51 - Turbulent Combustion : Modelling Turbulent Premixed Combustion (Continued...)
- Lecture 52 - Turbulent Combustion : Modelling Turbulent Premixed Combustion (Continued...)
- Lecture 53 - Turbulent Combustion : Modelling Turbulent Non-Premixed Combustion
- Lecture 54 - Turbulent Combustion : Modelling Turbulent Non-Premixed Combustion (Continued...)
- Lecture 55 - Turbulent Combustion : Modelling Turbulent Non-Premixed Combustion (Continued...)
- Lecture 56 - Turbulent Combustion : Modelling Turbulent Non-Premixed Combustion
- Lecture 57 - Turbulent Combustion : Modelling Turbulent Non-Premixed Combustion (Continued...)
- Lecture 58 - Multiphase Combustion : Introduction + Droplet Evaporation
- Lecture 59 - Multiphase Combustion : Droplet Combustion
- Lecture 60 - Multiphase Combustion : Spray Combustion

Lecture 1 - Introduction to Manufacturing Automation

Lecture 2 - Various Aspects of Manufacturing Automation

Lecture 3 - Part Transfer Mechanisms

Lecture 4 - Automated Flow Lines

Lecture 5 - Analysis of Automated Flow Lines

Lecture 6 - Vibratory Bowl Feeder

Lecture 7 - Analysis of Vibratory Bowl Feeder

Lecture 8 - Reciprocating Tube Hopper Feeder

Lecture 9 - Centreboard Hopper Feeder and its analysis

Lecture 10 - Reciprocating fork and External Gate Hopper Feeders

Lecture 11 - Rotary Disc Feeder and Centrifugal Hopper Feeder

Lecture 12 - Bladed Wheel and Tumbling Barrel Hopper Feeders

Lecture 13 - Rotary Centreboard and Magnetic Feeders

Lecture 14 - Part Orienting Devices

Lecture 15 - Feed Tracks and their analysis

Lecture 16 - Powered Feed Track and Escapements

Lecture 17 - Various Escapements and Part Placing Mechanisms

Lecture 18 - Design for Automatic Assembly

Lecture 19 - Performance and Economics of Assembly Systems

Lecture 20 - Performance of Indexing and Free Transfer Machines

Lecture 1 - Introduction to CIM - Part 1

Lecture 2 - Introduction to CIM - Part 2

Lecture 3 - Computers and Manufacturing Systems - Part 1

Lecture 4 - Computers and Manufacturing Systems - Part 2

Lecture 5 - Computers and Manufacturing Systems - Part 3

Lecture 6 - Computer Graphics - Part 1

Lecture 7 - Computer Graphics - Part 2

Lecture 8 - Computer Graphics - Part 3

Lecture 9 - Computer Graphics - Part 4

Lecture 10 - Geometric Modelling - Part 1

Lecture 11 - Geometric Modelling - Part 2

Lecture 12 - Computer Numerical Control - Part 1

Lecture 13 - Computer Numerical Control - Part 2

Lecture 14 - Computer Numerical Control - Part 3

Lecture 15 - Computer Numerical Control - Part 4

Lecture 16 - CNC Machining - Part 1

Lecture 17 - CNC Machining - Part 2

Lecture 18 - CNC Tooling

Lecture 19 - CNC Part Programming - Part 1

Lecture 20 - CNC Part Programming - Part 2

Lecture 21 - CNC Part Programming - Part 3

Lecture 22 - CNC Part Programming - Part 4

Lecture 23 - Laboratory Demonstration, Computer Aided Design - Part 1

Lecture 24 - Laboratory Demonstration, Computer Aided Design - Part 2

Lecture 25 - CAM softwares

Lecture 26 - Laboratory Demonstration, Computer Aided Manufacturing - Part 1

Lecture 27 - Laboratory Demonstration, Computer Aided Manufacturing - Part 2

Lecture 28 - Group Technology

Lecture 29 - Computer Aided Process Planning - Part 1

Lecture 30 - Computer Aided Process Planning - Part 2

Lecture 31 - Flexible Manufacturing System

- [Lecture 32 - Robotics](#)
- [Lecture 33 - Programmable Logic Controller](#)
- [Lecture 34 - Automatic Identification and Data Capture](#)
- [Lecture 35 - Computer Aided Quality Control - Part 1](#)
- [Lecture 36 - Computer Aided Quality Control - Part 2](#)
- [Lecture 37 - Laboratory Demonstration, Coordinate Measuring Machine](#)
- [Lecture 38 - Rapid Manufacturing - Part 1](#)
- [Lecture 39 - Rapid Manufacturing - Part 2](#)
- [Lecture 40 - Laboratory demonstration, Rapid Manufacturing - Part 1](#)
- [Lecture 41 - Laboratory demonstration, Rapid Manufacturing - Part 2](#)
- [Lecture 42 - Laboratory Demonstration, CAD using Fusion 360, an introduction](#)
- [Lecture 43 - Laboratory Demonstration, CAD using Fusion 360, Rendering and 3D printing](#)
- [Lecture 44 - Material Handling](#)
- [Lecture 45 - Laboratory Demonstration, Plant Simulation software - Part 1](#)
- [Lecture 46 - Laboratory Demonstration, Plant Simulation software - Part 2](#)
- [Lecture 47 - Laboratory Demonstration, Plant Simulation software - Part 3](#)
- [Lecture 48 - Computers in Manufacturing Industry, current scenario - Part 1](#)
- [Lecture 49 - Computers in Manufacturing Industry, current scenario - Part 2](#)
- [Lecture 50 - Computers in Manufacturing Industry, current scenario - Part 3](#)

Lecture 1 - Introduction to Machining

Lecture 2 - Mechanism of plastic deformation

Lecture 3 - Basic machining parameters, Cutting Tools and Types of Machining

Lecture 4 - Types of Chips, Tool nomenclature and tool angles

Lecture 5 - Tool Nomenclature in Normal Rake System and conversion of angles

Lecture 6 - Selection of Tool angles

Lecture 7 - Forces in machining, Merchant's Circle Diagram

Lecture 8 - Stress, Strain and Strain Rate and Shear Plane Angle

Lecture 9 - Numerical Examples; Lee and Shaffer's model

Lecture 10 - Friction in metal cutting: Zorev's Friction Model

Lecture 11 - Practical Machining Operations

Lecture 12 - Slab Milling; Measurement of Cutting Forces

Lecture 13 - Dynamometers; Tool Wear and Tool Life

Lecture 14 - Factors affecting tool life; Abrasive Machining Processes

Lecture 15 - Mechanics of Grinding Process

Lecture 16 - Chip length and specific energy in Grinding

Lecture 17 - Grinding wheel wear; Oblique Cutting

Lecture 18 - Rake angles in oblique cutting; Economics of Machining

Lecture 19 - Economics of Machining (Continued...); Thermal aspects of machining

Lecture 20 - Surface finish



Lecture 1 - Introduction to Cognitive Robotics (Private)

Lecture 2 - Smart Materials - I (Private)

Lecture 3 - Smart Materials - II (Private)

Lecture 4 - Smart Materials - III (Private)

Lecture 5 - Architecture of the Brain

Lecture 6 - Architecture of the Brain (Continued...)

Lecture 7 - Nerve Cells

Lecture 8 - Introduction to Synchronisation Models

Lecture 9 - Synchronisation models (Continued...)

Lecture 10 - Introduction to EEG

Lecture 11 - Theories of Intelligence - I

Lecture 12 - Theories of Intelligence - II

Lecture 13 - Kuramoto Model

Lecture 14 - Child Robot Interaction

Lecture 1 - Introduction to Robotics

Lecture 2 - Robot Joints and Work Volume

Lecture 3 - Spatial transformations

Lecture 4 - Homogenous Transformtions

Lecture 5 - Practice Problems with MATLAB in Rotation matrices

Lecture 6 - Kinematics: Derivation of Link Transformations

Lecture 7 - Problem Solving DH Parameters

Lecture 8 - Forward Kinematics

Lecture 9 - Inverse Kinematics

Lecture 10 - Problems in Kinematics

Lecture 11 - Inverse Kinematics of PUMA Robot

Lecture 12 - Jacobian and Singularity

Lecture 13 - Velocity and Static Forces

Lecture 14 - Dynamics - Lagrangian Euler

Lecture 15 - Newton Euler Dynamics

Lecture 16 - Trajectory Planning

Lecture 17 - Inverse Dynamics using MATLAB

Lecture 18 - Sensors

Lecture 19 - Actuators and Basic Control System

Lecture 20 - Block Diagram Reduction and Position Regulator

Lecture 21 - Control of a single joint

Lecture 22 - Non Linear Control of Manipulators

Lecture 23 - Force Control

Lecture 24 - Manipulator Mechanism Design

Lecture 25 - Industrial Robots and Applications

Lecture 26 - Specifications and Programming

Lecture 27 - VAL programming

Lecture 28 - Experiment With PUMA Robot Using VAL- II

Lecture 1 - Introduction to Acoustic Wave Propagation

Lecture 2 - D'Alembert's solution and 1-D Continuity equation

Lecture 3 - Muffler Acoustics-Application to Automotive Exhaust Noise Control

Lecture 4 - Linearization of governing equations, and Development of 1-D Acoustic wave and Helmholtz equation

Lecture 5 - Solution of 1-D Helmholtz equation: Propagation in 1-D ducts/pipes

Lecture 6 - 1-D Acoustic Wave Equation in Ducts Carrying Uniform Mean Flow: Derivation

Lecture 7 - 1-D Acoustic Wave Equation in Ducts Carrying Uniform Mean Flow: Solution

Lecture 8 - 3-D Acoustic Wave Equation in Rectangular and Circular Waveguides: Derivation, Modal Solution and Concept of Cut-on Frequency

Lecture 9 - Sound Pressure Level, Intensity Level and Sound Power Level

Lecture 10 - Acoustic Impedance and Reflection Coefficient

Lecture 11 - Lumped System Analysis: Inertance and Compliance

Lecture 12 - Lumped Analysis of a Uniform Pipe Closed/Open at an End, Concept of End Correction

Lecture 13 - Helmholtz Resonator, Electro-Acoustic Analogy and Layout of a typical engine exhaust system

Lecture 14 - Muffler Performance Measures: Insertion Loss

Lecture 15 - Muffler Performance Measures: Transmission Loss and Level Difference

Lecture 16 - Lumped Analysis of a Tube, Simple Area Discontinuity and Transfer Matrices

Lecture 17 - Sudden area Discontinuity (Continued...)

Lecture 18 - Simple Expansion Chamber Analysis Using Transfer Matrix Method

Lecture 19 - Transmission Loss (TL) Graph for a Simple Expansion Muffler (MATLAB)

Lecture 20 - Extended-Inlet and Extended-Outlet Muffler Analysis

Lecture 21 - Extended-Inlet and Extended-Outlet Muffler Analysis (Continued...)

Lecture 22 - TL Analysis of Extended-Inlet and Extended-Outlet Muffler (MATLAB)

Lecture 23 - TL Analysis of Side-Inlet and Side-Outlet Muffler Using Transfer Matrix Method

Lecture 24 - Wave Propagation in Gradually Varying Area Ducts: Webster's Horn Equation

Lecture 25 - Webster's Horn Equation (Continued...) and Exponential Ducts

Lecture 26 - Solution of Webster's Horn Equation for Conical Ducts

Lecture 27 - TL analysis for Conical Muffler Configurations (MATLAB)

Lecture 28 - Segmentation Approach for Analysing Gradually Varying Area Ducts (MATLAB)

Lecture 29 - Acoustic Intensity (Energy Flux) in a Pipe with Mean Flow, and Transmission Loss Expression

Lecture 30 - Aeroacoustic State Variables Transfer Matrix for a Tubular Element (Uniform Pipe)

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Lecture 31 - Transfer Matrix for Extended-Inlet and Outlet Element and Use of Perforated Elements in Commercial Mufflers

Lecture 32 - Two-interacting Duct Configurations: Development of Equations and Concentric Tube Resonators

Lecture 33 - Concentric Tube Resonator: Partially Perforated Pipe or Airway (MATLAB)

Lecture 34 - Review of Perforate Impedance Expressions

Lecture 35 - MATLAB Demonstration for Fully and Partially Perforated CTR

Lecture 36 - Cross-Flow elements: Setting-up the Equations

Lecture 37 - Cross-Flow elements: MATLAB Demonstration for Simple Configurations

Lecture 38 - Plug Mufflers, Three-pass Perforated Element Muffler (Commercial Configurations) - MATLAB

Lecture 39 - Multiply-Connected Mufflers: HQ Tubes

Lecture 40 - TL Analysis of HQ Tubes (MATLAB): Network Analysis and Analytical Formula

Lecture 41 - Transmission Loss in terms of Scattering and Impedance Matrix Parameters

Lecture 42 - Rectangular Chamber Muffler: Characterization and TL Analysis using 3-D Piston-driven Model

Lecture 43 - Circular Chambers: Characterization and TL Analysis Using 3-D Piston-driven Model

Lecture 44 - Analytical Mode-Matching for Extended-Inlet and Outlet Muffler: Setting-up of the Equations

Lecture 45 - MATLAB Demonstration for Transmission Loss Calculations

Lecture 46 - Dissipative Mufflers (Lined Circular duct) - A Brief Discussion

Lecture 47 - Summary of the Topics Covered in This Course, Topics to be Covered in a Future Course

[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10](#)

[Lecture 11](#)

[Lecture 12](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

[Lecture 20](#)

[Lecture 21](#)

[Lecture 22](#)

[Lecture 23](#)

[Lecture 24](#)

[Lecture 25](#)

[Lecture 26](#)

[Lecture 27](#)

[Lecture 28](#)

[Lecture 29](#)

[Lecture 30](#)

[Lecture 31](#)

[Lecture 32](#)

[Lecture 33](#)

[Lecture 34](#)

[Lecture 35](#)

Lecture 1 - Casting: Introduction to Casting

Lecture 2 - Various aspects of Casting

Lecture 3 - Patterns and Moulds

Lecture 4 - Sand Mould and Gating System

Lecture 5 - Gating System Design

Lecture 6 - Aspiration Effects and Riser Design

Lecture 7 - Solidification of Metals and Alloys

Lecture 8 - Stress, Strain and Strain Rate and Shear Plane Angle

Lecture 9 - Steps in Sand Casting Processes

Lecture 10 - Expendable Mould Casting Processes

Lecture 11 - Permanent Mould Casting

Lecture 12 - Various Casting Processes and Cost Analysis

Lecture 13 - Cost analysis, Casting Defects and Product Design

Lecture 14 - Introduction to Joining Processes

Lecture 15 - Characteristic Features of Welding Processes

Lecture 16 - Various Welding Processes

Lecture 17 - Advanced Welding Processes

Lecture 18 - Characteristic Features of Arc Welding

Lecture 19 - Shielded metal arc welding, MIG and TIG Welding

Lecture 20 - Gas Welding, Brazing and Soldering, Welding Defects

Lecture 1 - Historical Perspectives and Introduction to the Course

Lecture 2 - Finite Difference Method - Basic Idea of Discretization

Lecture 3 - Explicit and Implicit Formulations, Stability Analysis - Part 1

Lecture 4 - Stability Analysis - Part 2

Lecture 5 - Important Aspects of Flow Modelling - Part 1

Lecture 6 - Important Aspects of Flow Modelling - Part 2

Lecture 7 - Important Aspects of Flow Modelling - Part 3

Lecture 8 - Applications of Our Knowledge to a Problem of Practical Interest and Setting up an Algorithm

Lecture 9 - Finite Volume Method - Part 1

Lecture 10 - Finite Volume Method - Part 2

Lecture 11 - Finite Volume Method - Part 3

Lecture 12 - Introduction to Finite Element Method (Preliminary Concepts)

Lecture 13 - Introduction to Finite Element Method (Galerkin Weighted Residual Method)

Lecture 14 - Introduction to Finite element Method (Elemental contributions and formation of Global Matrix)

Lecture 15 - Vorticity Stream Function Approach (Formulation and Algorithm)

Lecture 16 - Vorticity-Stream Function Approach For Solving Navier-Stokes Equations

Lecture 17 - Solving Navier-Stokes Equations For Incompressible Flows using SIMPLE Algorithm - Part 1

Lecture 18 - Solving Navier-Stokes Equations For Incompressible Flows using SIMPLE Algorithm - Part 2

Lecture 19 - Solving Navier-Stokes Equations For Incompressible Flows using MAC Algorithm - Part 2

Lecture 20 - MAC Algorithm (Pressure - Velocity Iteration and the Solution)

Lecture 21 - MAC Algorithm (Solution of Energy Equation)

Lecture 22 - A Finite Volume Method to solve NS Equations in 3D Complex Geometry - Part 1

Lecture 23 - A Finite Volume Method to solve NS Equations in 3D Complex Geometry - Part 2

Lecture 24 - A Finite Volume Method to solve NS Equations in 3D Complex Geometry - Part 3

Lecture 25 - Mathematical Approaches to Turbulent Flows (Preliminaries and Modeling Framework)

Lecture 26 - Mathematical Approaches to Turbulent Flows (Modeling on the basis of RANS)



- Lecture 1 - Engineering Materials and Their Properties - 1
- Lecture 2 - Engineering Materials and Their Properties - 2
- Lecture 3 - Engineering Materials and Their Properties - 3
- Lecture 4 - Metal Machining-1: Introduction to Machining
- Lecture 5 - Metal Machining-2: Mechanism of plastic deformation
- Lecture 6 - Metal Machining-3: Types of Chips, Tool nomenclature and tool angles
- Lecture 7 - Metal Machining-4: Selection of Tool angles, Forces in machining
- Lecture 8 - Metal Machining-5: Merchant's Circle Diagram
- Lecture 9 - Metal Machining-6: Friction in Metal Cutting
- Lecture 10 - Metal Machining-7: Practical Machining Operations; Force Measurement
- Lecture 11 - Metal Machining-8: Force Measurement
- Lecture 12 - Metal Machining-9: Tool Wear and Tool Life
- Lecture 13 - Metal Machining-10: Factors affecting Tool Life
- Lecture 14 - Metal Machining-11: Abrasive Machining Processes
- Lecture 15 - Metal Machining-12: Abrasive Machining Processes
- Lecture 16 - Metal Machining-13: Grinding; Economics of Machining
- Lecture 17 - Machining-14: Economics of Machining
- Lecture 18 - Non-Traditional Machining-1: Introduction; Classification
- Lecture 19 - Non-Traditional Machining-2: Various Non-Traditional Machining Processes
- Lecture 20 - Non-Traditional Machining-3, Computer Numerical Control (CNC) -1
- Lecture 21 - Computer Numerical Control (CNC) - 2
- Lecture 22 - Computer Numerical Control (CNC) - 3
- Lecture 23 - Engineering Metrology
- Lecture 24 - Laboratory Demonstration/Hands-On Practice - 1
- Lecture 25 - Laboratory Demonstration/Hands-On Practice - 2
- Lecture 26 - Laboratory Demonstration/Hands-On Practice - 3
- Lecture 27 - Laboratory Demonstration/Hands-On Practice - 4
- Lecture 28 - Laboratory Demonstration/Hands-On Practice - 5
- Lecture 29 - Laboratory Demonstration/Hands-On Practice - 6
- Lecture 30 - Laboratory Demonstration/Hands-On Practice - 7
- Lecture 31 - Laboratory Demonstration/Hands-On Practice - 8

[Lecture 32 - Laboratory Demonstration/Hands-On Practice - 9](#)

[Lecture 33 - Laboratory Demonstration/Hands-On Practice - 10](#)

- Lecture 1 - Introduction and Classification
- Lecture 2 - Introduction and Classification (Continued...)
- Lecture 3 - Review of the Fundamental Laws
- Lecture 4 - Equation of Motion in Rotating Frame
- Lecture 5 - Euler Equation for Turbomachinery
- Lecture 6 - Euler Equation for Turbomachinery: Illustration
- Lecture 7 - Problem Session - Chapter-1: Applications of Euler Equation
- Lecture 8 - Similarity Analysis - I
- Lecture 9 - Similarity Analysis - II
- Lecture 10 - Similarity Analysis - III
- Lecture 11 - Problem Session - II
- Lecture 12 - Cassade Analysis - I
- Lecture 13 - Cassade Analysis - II
- Lecture 14 - Cassade Analysis - III
- Lecture 15 - Cassade Analysis - IV
- Lecture 16 - Cassade Analysis (Problem Session)
- Lecture 17 - Gas Turbine Cycle Analysis - I
- Lecture 18 - Gas Turbine Cycle Analysis - II
- Lecture 19 - Gas Turbine Cycle Analysis - III
- Lecture 20 - Gas Turbine Cycle Analysis - IV
- Lecture 21 - Gas Turbine Cycle Analysis - V
- Lecture 22 - Illustrative Examples Gas Turbine Cycle
- Lecture 23 - Illustrative Examples Jet Propulsion
- Lecture 24 - Axial Flow Compressor - I
- Lecture 25 - Axial Flow Compressor - II
- Lecture 26 - Axial Flow Compressor - III
- Lecture 27 - Axial Flow Compressor - IV
- Lecture 28 - Illustrative Examples Axial Flow Compressor
- Lecture 29 - Centrifugal Compressor - I
- Lecture 30 - Centrifugal Compressor - II
- Lecture 31 - Centrifugal Compressor - III

[Lecture 32 - Axial Flow Turbine - I](#)

[Lecture 33 - Axial Flow Turbine - II](#)

[Lecture 34 - Axial Flow Turbine - III](#)

[Lecture 35 - Axial Flow Turbine - IV](#)

[Lecture 36 - Axial Flow Turbine - V](#)

[Lecture 37 - Axial Flow Steam Turbine - I](#)

[Lecture 38 - Axial Flow Steam Turbine - II](#)

[Lecture 39 - Axial Flow Steam Turbine - III](#)

[Lecture 40 - Axial Flow Steam Turbine - IV](#)

[Lecture 41 - Axial Flow Steam Turbine - V](#)

[Lecture 42 - Axial Flow Steam Turbine - VI](#)

[Lecture 43 - Hydraulic Turbines - I \(Pelton Wheel\)](#)

[Lecture 44 - Hydraulic Turbines - II \(Illustrations on Pelton Wheel\)](#)

[Lecture 45 - Hydraulic Turbines - III \(Reaction Turbine\)](#)

[Lecture 46 - Hydraulic Turbines - IV \(Cavitation\)](#)

[Lecture 47 - Hydraulic Turbines - V \(Illustrations on Reaction Turbine\)](#)

[Lecture 48 - CFD and Turbomachinery - I](#)

[Lecture 49 - CFD and Turbomachinery - II](#)

[Lecture 50 - CFD and Turbomachinery - III](#)

Lecture 1 - Introduction

Lecture 2 - Joints and Degrees of Freedom

Lecture 3 - Work Volume and Rotation Transformation

Lecture 4 - Transformations

Lecture 5 - Kinematics

Lecture 6 - Bug Algorithms

Lecture 7 - Configuration Space

Lecture 8 - C Obstacle

Lecture 9 - Topology of C Space

Lecture 10 - Road Map Methods

Lecture 11 - Cell Decomposition Methods

Lecture 12 - Sampling Based Planning

Lecture 13 - Potential Field Methods - I

Lecture 14 - Navigation Function and Potential Field in 3D

Lecture 15 - Basic Search Algorithms

Lecture 16 - Motion Planning with Kinematic Constraints

Lecture 17 - Controllability

Lecture 18 - Kinematic Constraints and Multifinger Robot

Lecture 19 - Multifinger Robot Hands

Lecture 20 - Optimization in Motion Planning

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**NPTEL : NOC: Metal Additive Manufacturing (Mechanical Engineering)**

**Co-ordinators : Prof. Amandeep Singh Oberoi, Prof. Janakranjan Ramkumar**

- Lecture 1 - Introduction to Metal Additive Manufacturing
- Lecture 2 - Additive Manufacturing Processes: Classification and Challenges
- Lecture 3 - Additive Manufacturing Processes: Applications and Challenges
- Lecture 4 - Metal Additive Manufacturing, Glossary - Part 1
- Lecture 5 - Metal Additive Manufacturing, Glossary - Part 2
- Lecture 6 - CAD for Additive Manufacturing
- Lecture 7 - Basic Processes - Part 1
- Lecture 8 - Basic Processes - Part 2
- Lecture 9 - Laser Based Processes - Part 1
- Lecture 10 - Laser Based Processes - Part 2
- Lecture 11 - Electron Beam Process
- Lecture 12 - Powder/Wire Fed Systems
- Lecture 13 - Solidification of Parts - Part 1
- Lecture 14 - Solidification of Parts - Part 2
- Lecture 15 - Solidification of Parts - Part 3
- Lecture 16 - Process Parameters
- Lecture 17 - MAM Printed Parts: Mechanical Properties, Hardness
- Lecture 18 - MAM Printed Parts: Mechanical Properties, Strength
- Lecture 19 - Common Defects and Post Processing
- Lecture 20 - Design for Additive Manufacturing (DFAM) - Part 1
- Lecture 21 - Design for Additive Manufacturing (DFAM) - Part 2
- Lecture 22 - Topology Optimization Techniques
- Lecture 23 - On-Machine Sensing in MAM - Part 1
- Lecture 24 - On-Machine Sensing in MAM - Part 2
- Lecture 25 - In-situ Control Systems
- Lecture 26 - Additive Manufacturing of Metal Matrix Composites - Part 1
- Lecture 27 - Additive Manufacturing of Metal Matrix Composites - Part 2
- Lecture 28 - Additive Manufacturing of Metal Matrix Composites - Part 3
- Lecture 29 - Additive Manufacturing of Metal Matrix Composites - Part 4
- Lecture 30 - Reverse Engineering in MAM - Part 1
- Lecture 31 - Reverse Engineering in MAM - Part 2

[Lecture 32 - Reverse Engineering in MAM - Laboratory Demonstration - I](#)

[Lecture 33 - Reverse Engineering in MAM - Laboratory Demonstration - II](#)

[Lecture 34 - CAD and Topology Optimization Laboratory Demonstration - I](#)

[Lecture 35 - CAD and Topology Optimization Laboratory Demonstration - II](#)

[Lecture 36 - Non-Destructive Testing - Part 1](#)

[Lecture 37 - Non-Destructive Testing - Part 2](#)

[Lecture 38 - Sustainability in MAM - Part 1](#)

[Lecture 39 - Sustainability in MAM - Part 2](#)

[Lecture 40 - Sustainability in MAM - Part 3](#)

[Lecture 41 - Metal 3D Printing Laboratory Demonstration - I](#)

[Lecture 42 - Metal 3D Printing Laboratory Demonstration - II](#)

[Lecture 43 - Safety in MAM](#)

[Lecture 44 - Costing in MAM - Part 1](#)

[Lecture 45 - Costing in MAM - Part 2](#)

[Lecture 46 - Costing in MAM - Part 3](#)

[Lecture 47 - Industry 4.0 and MAM](#)

[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10](#)

[Lecture 11](#)

[Lecture 12](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

[Lecture 20](#)

[Lecture 21](#)

[Lecture 22](#)

[Lecture 23](#)

[Lecture 24](#)

[Lecture 25](#)

[Lecture 26](#)

[Lecture 27](#)

[Lecture 28](#)

[Lecture 29](#)

[Lecture 30](#)

[Lecture 31](#)



[Lecture 32](#)

[Lecture 33](#)

[Lecture 34](#)

[Lecture 35](#)

[Lecture 36](#)

[Lecture 37](#)

[Lecture 38](#)

[Lecture 39](#)

Lecture 1

Lecture 2

Lecture 3

Lecture 4

Lecture 5

Lecture 6

Lecture 7

Lecture 8

Lecture 9

Lecture 10

Lecture 11

Lecture 12

Lecture 13

Lecture 14

Lecture 15

Lecture 16

Lecture 17

Lecture 18

Lecture 19

Lecture 20

Lecture 21

Lecture 22

Lecture 23

Lecture 24

Lecture 25

Lecture 26

Lecture 27

Lecture 28

Lecture 29

Lecture 30

[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10](#)

[Lecture 11](#)

[Lecture 12](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

[Lecture 20](#)

[Lecture 21](#)

[Lecture 22](#)

[Lecture 23](#)

[Lecture 24](#)

[Lecture 25](#)

[Lecture 26](#)

[Lecture 27](#)

[Lecture 28](#)

[Lecture 29](#)

[Lecture 30](#)

[Lecture 31](#)

[Lecture 32](#)

[Lecture 33](#)

[Lecture 34](#)

[Lecture 35](#)

[Lecture 36](#)

[Lecture 37](#)

[Lecture 38](#)

[Lecture 39](#)

[Lecture 40](#)

[Lecture 41](#)

[Lecture 42](#)

[Lecture 43](#)

[Lecture 44](#)

[Lecture 45](#)

[Lecture 46](#)

[Lecture 47](#)

[Lecture 48](#)

[Lecture 49](#)

[Lecture 50](#)

[Lecture 51](#)

[Lecture 52](#)

[Lecture 53](#)

[Lecture 54](#)

[Lecture 55](#)

[Lecture 56](#)

[Lecture 57](#)

[Lecture 58](#)

[Lecture 59](#)

[Lecture 60](#)

[Lecture 61](#)

[Lecture 62](#)

[Lecture 63](#)

[Lecture 64](#)

[Lecture 65](#)

[Lecture 66](#)

[Lecture 67](#)

[Lecture 68](#)

[Lecture 69](#)

[Lecture 70](#)

[Lecture 71](#)

[Lecture 72](#)

[Lecture 73](#)

[Lecture 74](#)

[Lecture 75](#)

[Lecture 76](#)

[Lecture 77](#)

[Lecture 78](#)

[Lecture 79](#)

[Lecture 80](#)

[Lecture 81](#)

[Lecture 82](#)

[Lecture 83](#)

[Lecture 84](#)

[Lecture 85](#)

[Lecture 86](#)

[Lecture 87](#)

[Lecture 88](#)

[Lecture 89](#)

[Lecture 90](#)

[Lecture 91](#)

[Lecture 92](#)

[Lecture 93](#)

[Lecture 94](#)

[Lecture 95](#)

[Lecture 96](#)

[Lecture 97](#)

[Lecture 98](#)

[Lecture 99](#)

[Lecture 100](#)

[Lecture 101](#)

[Lecture 102](#)

[Lecture 103](#)

[Lecture 104](#)

[Lecture 105](#)

[Lecture 106](#)

[Lecture 107](#)

[Lecture 108](#)

[Lecture 109](#)

[Lecture 110](#)

[Lecture 111](#)

[Lecture 112](#)

[Lecture 113](#)

[Lecture 114](#)

[Lecture 115](#)

[Lecture 116](#)

[Lecture 117](#)

[Lecture 118](#)

[Lecture 119](#)

[Lecture 120](#)

[Lecture 121](#)

[Lecture 122](#)

[Lecture 123](#)

[Lecture 124](#)

[Lecture 125](#)

[Lecture 126](#)

[Lecture 127](#)

[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10](#)

[Lecture 11](#)

[Lecture 12](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

[Lecture 20](#)

[Lecture 21](#)

[Lecture 22](#)

[Lecture 23](#)

[Lecture 24](#)

[Lecture 25](#)

[Lecture 26](#)

[Lecture 27](#)

[Lecture 28](#)

[Lecture 29](#)

[Lecture 30](#)

[Lecture 31](#)

[Lecture 32](#)

[Lecture 33](#)

[Lecture 34](#)

[Lecture 35](#)

[Lecture 36](#)

[Lecture 37](#)

[Lecture 38](#)

[Lecture 39](#)

[Lecture 40](#)

[Lecture 41](#)

[Lecture 42](#)

[Lecture 43](#)

[Lecture 44](#)

[Lecture 45](#)

[Lecture 46](#)

[Lecture 47](#)

[Lecture 48](#)

[Lecture 49](#)

[Lecture 50](#)

[Lecture 51](#)

[Lecture 52](#)



[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10](#)

[Lecture 11](#)

[Lecture 12](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

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[Lecture 23](#)

[Lecture 24](#)

[Lecture 25](#)

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[Lecture 36](#)

[Lecture 37](#)

[Lecture 38](#)

[Lecture 39](#)

[Lecture 40](#)

[Lecture 41](#)

[Lecture 42](#)

[Lecture 43](#)

[Lecture 44](#)

[Lecture 45](#)

[Lecture 46](#)

[Lecture 47](#)

[Lecture 48](#)

[Lecture 49](#)

[Lecture 50](#)

[Lecture 51](#)

[Lecture 52](#)

[Lecture 53](#)

[Lecture 54](#)

[Lecture 55](#)

Lecture 1 - Introduction to Advanced Manufacturing Processes

Lecture 2 - Ultrasonic Machining

Lecture 3

Lecture 4

Lecture 5 - Abrasive Jet Machining

Lecture 6 - Adrasive Jet Micro-Machining and Mask Materials for AJMM

Lecture 7 - Electro-Chemical Machining

Lecture 8 - Electrochemical Machining - I

Lecture 9 - Electrochemical Machining - II

Lecture 10 - Electrochemical Machining - III

Lecture 11 - Electrochemical Machining - IV

Lecture 12 - Electrochemical Machining - V

Lecture 13 - Electrochemical Machining - VI

Lecture 14 - Electrochemical Machining - VII

Lecture 15 - Electrochemical Machining - VIII

Lecture 16 - Machining Applications

Lecture 17 - Electric Discharge Machining - I

Lecture 18 - Electric Discharge Machining - II

Lecture 19 - Electric Discharge Machining - III

Lecture 20 - Electric Discharge Machining - IV

Lecture 21 - Electric Discharge Machining - IV and Electron Beam Machining - I

Lecture 22 - Electron Beam Machining - II

Lecture 23 - Laser Beam Machining - I

Lecture 24 - Laser Beam Machining - II

Lecture 25 - Silicon and Processing of Silicon - I

Lecture 26 - Silicon and Processing of Silicon - II

Lecture 27 - Polymer Processing

Lecture 28 - Advanced Finishing Processes

Lecture 29 - Lab Session-I: Water Abrasive Jet Machining Process

Lecture 30 - Lab Session-II: Electro-discharge Machining Process - I

Lecture 31 - Lab Session-III: Electro-discharge Machining Process - II

[Lecture 32 - Lab Session-IV: Laser Beam Machining](#)

[Lecture 33 - Lab Session-V: Photolithography](#)

Lecture 1 - Units, Dimensions, and Dimensional Analysis - Part 1

Lecture 2 - Units, Dimensions, and Dimensional Analysis - Part 2

Lecture 3 - Laws of Motion, Inertia and Momentum

Lecture 4 - Scalars and Vectors, Vector Algebra

Lecture 5 - Statics, Kinetics and Kinematics

Lecture 6 - Friction and Lubrication

Lecture 7 - Moment of Inertia and Gravity

Lecture 8 - Mechanical Properties - Stress Strain and Residual Stress

Lecture 9 - Stress Strain Curve, Elasticity and Poission's Ratio

Lecture 10 - Principal Stress and Castigliano's Theorem

Lecture 11 - Hardness, Toughness, Impact and Creep

Lecture 12 - Homogeneous Materials, Isotropic and Anisotropic Materials

Lecture 13 - Static and Fatigue Loading, Critical Loads - Part 1

Lecture 14 - Static and Fatigue Loading, Critical Loads - Part 2

Lecture 15 - Tutorial-1 - Part 1

Lecture 16 - Tutorial-1 - Part 2

Lecture 17 - Tutorial-2 - Part 1

Lecture 18 - Tutorial-2 - Part 2

Lecture 19 - Stress in Cylinders and Spheres - Part 1

Lecture 20 - Stress in Cylinders and Spheres - Part 2

Lecture 21 - Buckling of columns

Lecture 22 - Materials, Metals and Composites - Part 1

Lecture 23 - Materials, Metals and Composites - Part 2

Lecture 24 - Mohr's circle

Lecture 25 - Shear Force and Bending Moment Diagram - Part 1

Lecture 26 - Shear Force and Bending Moment Diagram - Part 2

Lecture 27 - Shear Force and Bending Moment Diagram - Part 3

Lecture 28 - Factor of Safety, Degree of Freedom, Endurance Limit

Lecture 29 - Tutorial-3 - Part 1

Lecture 30 - Tutorial-3 - Part 2

Lecture 31 - Linkages and Mechanisms

[Lecture 32 - Stress Concentration and Notch Sensitivity - Part 1](#)

[Lecture 33 - Stress Concentration and Notch Sensitivity - Part 2](#)

[Lecture 34 - Brittleness and ductility](#)

[Lecture 35 - Testing for Tension](#)

[Lecture 36 - Testing for Compression](#)

[Lecture 37 - Testing for bending](#)

[Lecture 38 - Testing for impact loads](#)

[Lecture 39 - Testing for hardness, and fracture](#)

[Lecture 40 - Spring-Mass Systems - Part 1](#)

[Lecture 41 - Spring-Mass Systems - Part 2](#)

[Lecture 42 - Gears: Basic Concepts](#)

[Lecture 43 - Cam and Follower Design](#)

[Lecture 44 - Couplings and Shafts](#)

[Lecture 45 - Keys, Nuts, Bolts, Screws and Fasteners](#)

[Lecture 46 - Chains, Pulleys, and Belts](#)

[Lecture 47 - Clutches, Brakes and Flywheels](#)

[Lecture 48 - Permanent Joints](#)

[Lecture 49 - Vibration and Acoustics](#)

[Lecture 50 - Introduction to Engineering Statistics](#)

Lecture 1 - Introduction to Computational Fluid Dynamics and Principles of Conservation

Lecture 2 - Conservation of Mass and Momentum: Continuity and Navier Stokes Equation

Lecture 3 - Navier Stokes Equation (Continued.)

Lecture 4 - Energy Equation and General Structure of Conservation Equations

Lecture 5 - Classification of Partial Differential Equations and Physical Behaviour

Lecture 6 - Classification of Partial Differential Equations and Physical Behaviour (Continued.)

Lecture 7 - Approximate Solutions of Differential Equations: Error Minimization Principles

Lecture 8 - Approximate Solutions of Differential Equations: Variational Principles and Weighted Residual Approach

Lecture 9 - Weighted Residual Approach and Introduction to Discretization

Lecture 10 - Fundamentals of Discretization: Finite Element Method

Lecture 11 - Fundamentals of Discretization: Finite Difference and Finite Volume Method

Lecture 12 - Fundamentals of Discretization: Finite Volume Method (Continued.)

Lecture 13 - Finite Volume Method: Some Conceptual Basics and Illustrations through 1-D Steady State Diffusion Problems

Lecture 14 - Finite Volume Method: Boundary Condition Implementation and Discretization of Unsteady State Problems

Lecture 15 - Finite Volume Method: Discretization of Unsteady State Problems

Lecture 16 - Important Consequences of Discretization of Unsteady State Problems

Lecture 17 - Important Consequences of Discretization of Time Dependent Diffusion Type Problems (Continued.) and Stability Analysis

Lecture 18 - Discretization of Hyperbolic Equations: Stability Analysis

Lecture 19 - PART 1 : Stability of Second Order Hyperbolic Equations PART 2 : Mid-Semester Assessment Review (Questions and Answers)

Lecture 20 - PART 1: Mid-Semester Assessment Review (Questions and Answers) (Continued.) PART 2: Finite Volume Discretization of 2-D Unsteady State Diffusion Type

Lecture 21 - Solution of Systems of Linear Algebraic Equations

Lecture 22 - Solution of Systems of Linear Algebraic Equations: Elimination Methods

Lecture 23 - Solution of Systems of Linear Algebraic Equations: Elimination Methods (Continued.)

Lecture 24 - Elimination Methods: Error Analysis

Lecture 25 - Iterative Methods for Numerical Solution of Systems of Linear Algebraic Equations

Lecture 26 - Iterative Methods for Numerical Solution of Systems of Linear Algebraic Equations (Continued.)

Lecture 27 - Iterative Methods: Further Examples

Lecture 28 - PART 1: Combination of Iteration & Elimination Techniques PART 2: Introduction to Gradient Search Methods

Lecture 29 - Gradient Search Methods (Continued.)

Lecture 30 - Discretization of Convection-Diffusion Equations: A Finite Volume Approach

[Lecture 31 - Discretization of Convection-Diffusion Equations: A Finite Volume Approach \(Continued.\)](#)

[Lecture 32 - Discretization of Convection- Diffusion Equations: A Finite Volume Approach \(Continued.\)](#)

[Lecture 33 - Discretization of Convection -Diffusion Equations: A Finite Volume Approach \(Continued.\)](#)

[Lecture 34 - Discretization of Convection-Diffusion Equations: A Finite Volume Approach \( Continued.\)](#)

[Lecture 35 - Discretization of Navier Stokes Equations](#)

[Lecture 36 - Discretization of Navier Stokes Equations \( Continued.\)](#)

[Lecture 37 - Discretization of Navier Stokes Equations \( Continued. \)](#)

[Lecture 38 - PART 1 : Discretization of Navier Stokes Equations \(Continued.\) PART 2 : Fundamentals of Unstructured Grid Formulation](#)

[Lecture 39 - Unstructured Grid Formulation \(Continued.\)](#)

[Lecture 40 - What is there in implementing a CFD Code](#)

[Lecture 41 - Introduction to Turbulence Modeling](#)

[Lecture 42 - Introduction to Turbulence Modeling \(Continued.\)](#)

[Lecture 43 - End Semester Questions Review](#)



Lecture 1 - What is Hydraulic and Pneumatic System

Lecture 2 - Basic Components, Symbols and Circuits

Lecture 3 - Incompressible Fluids - Some Fundamental Properties

Lecture 4 - Incompressible Fluid Flow related to Fluid Drive

Lecture 5 - Capillary Fluid (incompressible) Flow and Hydrodynamic Lubrication

Lecture 6 - Basis for Calculating Hydraulic Systems

Lecture 7 - Different types of Valves - Features and Operations - I

Lecture 8 - Hydraulic Valves (General) Different types of Valves - Features and Operations - II

Lecture 9 - Hydraulic Circuits and Valves

Lecture 10 - Hydraulic Servomechanism and Servo and Proportional Control Valves

Lecture 11 - Basic Spool Valve Design Analysis

Lecture 12 - General Control Valve Analysis

Lecture 13 - Critical Centre Spool Valve Analysis

Lecture 14 - Critical Centre Spool Valve Analysis - Stroking Forces

Lecture 15 - Proportional Solenoid Pilot Operated Two Stage Pressure Relief Valve

Lecture 16 - Proportional Solenoid Pilot Operated Two Stage Pressure Relief Valve (Continued...)

Lecture 17 - Introduction to Positive Displacement Hydrostatic Units (Hydraulic Pumps and Motors)

Lecture 18 - Basic features of some Hydraulic Pumps and Motors

Lecture 19 - Analysis of an axial - Piston Swash Plate type Hydrostatic Pump (Discharge Flow Characteristics)

Lecture 20 - Analysis of an axial - Piston Swash Plate type Hydrostatic Pump (Estimation of Torque on Drive Shaft and Swash Plate)

Lecture 21 - Analysis of an Axial - Piston Swash Plate type Hydrostatic unit (Pressure Ripple and Swash Plate Torque)

Lecture 22 - Design Analysis of Gear Pumps - I

Lecture 23 - Design Analysis of Gear Pumps - II

Lecture 24 - Basic Concept of Hydrostatic Transmission (HST) System

Lecture 25 - Selection of HST units and components

Lecture 26 - Regenerative Circuits

Lecture 27 - Introduction to Fluid Logic

Lecture 28 - Basic Devices, Symbols and Circuits

Lecture 29 - Logic Circuits

Lecture 30 - Design Analysis of ORBIT Motor - I : Basic Design and Feature

Lecture 31 - Design Analysis of ORBIT Motor - II : Geometric Volume Displacement

[Lecture 32 - Design Analysis of ORBIT Motor - III : Output torque and stress, Deformation, Gap at Contacts](#)

[Lecture 33 - Application and Selection of Accumulators - Part I](#)

[Lecture 34 - Application and Selection of Accumulators - Part II](#)

[Lecture 35 - Hydraulic Circuits in Industrial Applications](#)

[Lecture 36 - Air preparation - Compressor and Accessories](#)

[Lecture 37 - Pneumatic Circuits](#)

[Lecture 38 - Analysis of Three - Way \(Spool and Flapper Nozzle Valve\)](#)

[Lecture 39 - Analysis of Flapper Nozzle Valves](#)

[Lecture 40 - Flow Force Compensation and Spool Design \(Electro - hydraulic valves\)](#)

[Lecture 41 - Premier and Guide to Oil - hydraulic fluids ; and Introduction to Fluid Power Symbols](#)

[Lecture 42 - Symbols in Oil Hydraulics](#)

[Lecture 43 - Appendices Tutorial on Basic Calculation on HST System and Hydraulic Fluids](#)

Lecture 1 - Introduction

Lecture 2 - Principles of Maintenance

Lecture 3 - Failure Modes Effects and Criticality Analysis

Lecture 4 - Fault Diagnostics and Prognostics

Lecture 5 - Basics of Machinery Vibration

Lecture 6 - Engineering Applications of Vibration

Lecture 7 - Rotordynamics

Lecture 8 - Time Domain Signal Analysis

Lecture 9 - Frequency Domain Signal Analysis

Lecture 10 - Computer Aided Data Acquisition

Lecture 11 - FFT Analysis

Lecture 12 - Modulation and Sidebands

Lecture 13 - Envelope Analysis

Lecture 14 - Cepstrum Analysis

Lecture 15 - Order Analysis

Lecture 16 - Basics of Instrumentation

Lecture 17 - Sensors and Transducers

Lecture 18 - Data Recording and Transmission

Lecture 19 - Vibration Transducers

Lecture 20 - Vibration Monitoring

Lecture 21 - Basics of Noise and Noise Monitoring

Lecture 22 - Numericals in Noise Vibration and Data Acquisition

Lecture 23 - Unbalance Detection

Lecture 24 - Field Balancing

Lecture 25 - Misalignment Detection

Lecture 26 - Cracked Shaft Detection

Lecture 27 - Looseness and Rub Detection

Lecture 28 - Ball and Journal Bearings

Lecture 29 - Gear Fault Detection

Lecture 30 - Fans, Blowers and Compressors

Lecture 31 - Pumps and Turbines

[Lecture 32 - Contaminant Analysis](#)

[Lecture 33 - Oil Analysis](#)

[Lecture 34 - Fault Detection in Motors and Transformers](#)

[Lecture 35 - Motor Current Signature Analysis](#)

[Lecture 36 - Thermography](#)

[Lecture 37 - Ultrasonics](#)

[Lecture 38 - Acoustic Emission and Eddy Current Testing](#)

[Lecture 39 - Radiography, Dye Penetrant Test and Visual Inspection](#)

[Lecture 40 - Case Studies](#)

**NPTEL : Solar Energy Technology (Mechanical Engineering)**

**Co-ordinators : Prof. V.V. Satyamurty**

Lecture 1 - Energy and Dependence on External Sources and Sun, Physical Descriptions and Reactions

Lecture 2 - Sun - Earth Geometry

Lecture 3 - Terminology Extra - Terrestrial Radiation Terrestria Radiation

Lecture 4 - Measuring Instruments

Lecture 5 - Estimation of Solar Radiation or Details

Lecture 6 - Radiation Processing - Long Term

Lecture 7 - Evaluation of the Apparent Sunrise and Sunset Angles

Lecture 8 - Estimation of Daily/Monthly Average daily Tilt Factor Under Terrestrial Conditions

Lecture 9 - Solar Colector Basics

Lecture 10 - Transmission - Absorptance Product

Lecture 11 - Daily (Or Monthly Average Daily) Transmittance - Absorptance Product Analytical Evaluation

Lecture 12 - Theory of Flat Plate Collectors - Liquid Based (A)

Lecture 13 - Theory of Flat Plate Collectors - Liquid Based (B)

Lecture 14 - Theory of Flat Plate Collectors - Liquid Based (C)

Lecture 15 - Mean temperature and Heat Capacity Effects

Lecture 16 - Theory of Air Based Solar Flat Plate Collectors

Lecture 17 - Theory of Air Based Solar Flat Plate Collectors (Continued.)

Lecture 18 - Other Collector Geometries

Lecture 19 - Concentrating Collectors

Lecture 20 - Concentrating Collectors (Continued.)

Lecture 21 - Concentrating Collectors (Continued.)

Lecture 22 - Compound Parabolic Collectors

Lecture 23 - Exercise - I

Lecture 24 - Exercise - I (Continued.)

Lecture 25 - Device and System Performance

Lecture 26 - Long Term Solar Energy System Performance

Lecture 27 - Exercise - I (Continued.)

Lecture 28 - Long Term Solar Energy System Performance Simplified Design Methods

Lecture 29 - Long Term Solar Energy System Performance Simplified Design Methods (Continued.)

Lecture 30 - Monthly Average Daily Utilizability

Lecture 31 - The  $\bar{\phi}$  - f chart method (Continued.)

[Lecture 32 - The  \$\phi\$ \(bar\) - f chart method Tank Losses and Finite Heat Exchanger](#)

[Lecture 33 - Exercise - 2](#)

[Lecture 34 - Exercise - 2 \(Continued.\)](#)

[Lecture 35 - Exercise - 2 \(Continued.\)](#)

[Lecture 36 - Economic Analysis](#)

[Lecture 37 - Life Cycle Savings : The P1 and P2 Method](#)

[Lecture 38 - Passive Devices](#)

[Lecture 39 - Passive Architecture, Overhangs and Wing Walls](#)

[Lecture 40 - Passive Architecture, Overhangs and Wing Walls \(Continued.\)](#)

[Lecture 41 - Summary](#)

[Lecture 42 - Summary \(Continued.\)](#)

[Lecture 43 - Summary \(Continued.\)](#)

Lecture 1 - Introduction

Lecture 2 - CVD Reaction

Lecture 3 - Adhesion of Surface Coating

Lecture 4 - CVD System

Lecture 5 - CVD of TiC

Lecture 6 - Chemical Vapour Deposition of Nitride Coating

Lecture 7 - Chemical Vapour Deposition of Carbo-Nitride Coating

Lecture 8 - Chemical Vapour Deposition of Chromium

Lecture 9 - Chemical Vapour Deposition of Aluminium Oxide

Lecture 10 - Chemical Vapour Deposition of Diamond

Lecture 11 - Vacuum Evaporation Deposition

Lecture 12 - Reactive Evaporation Deposition

Lecture 13 - Cathodic Arc Evaporation Deposition

Lecture 14 - Sputtering

Lecture 15 - Magnetron Sputtering

Lecture 16 - Unbalanced Magnetron Sputtering

Lecture 17 - Radio frequency and pulsed DC sputtering

Lecture 18 - Sputter Deposition of Nitride Coating

Lecture 19 - Sputter Deposition of Molybdenum Di Sulphide Coating

Lecture 20 - Influence of Architecture of Sputter Deposited Molybdenum Di Sulphide Coating

Lecture 21 - Electro Plating, Anodizing and Electro-Less Plating

Lecture 22 - Coating of Monolayer Abrasive Grain by Electro Plating

Lecture 23 - Mechanism of Wetting

Lecture 24 - Coating on Ceramics by Wetting

Lecture 25 - Coating of Monolayer Abrasive Grain by Wetting

Lecture 26 - Coating on Abrasive Grain

Lecture 27 - Combustion Spray Process

Lecture 28 - Plasma Spray Process

Lecture 29 - Mechanical, Chemical and Ion-Assisted Method

Lecture 30 - Combustion Spray Process

Lecture 31 - Production of Low Vacuum

[Lecture 32 - Production of High Vacuum](#)

[Lecture 33 - Measurement of Low Pressure and Gas Flow in Coating Deposition System](#)

[Lecture 34 - Physical Characterization](#)

[Lecture 35 - Assessment of Coating Hardness](#)

[Lecture 36 - Assessment of Friction and Wear of Coating](#)

[Lecture 37 - Assessment of Surface Roughness and Thickness of Coating](#)

[Lecture 38 - Assessment of Adhesion of Coating](#)

[Lecture 39 - Performance Evaluation of TiN Coated Tool](#)

[Lecture 40 - Performance Evaluation of HFCVD Diamond Coated Tool](#)



- Lecture 1 - Transverse Vibrations of Strings - I
- Lecture 2 - Transverse Vibrations of Strings - II
- Lecture 3 - Axial and Torsional Vibrations of Bars
- Lecture 4 - Variational Formulation - I
- Lecture 5 - Variational Formulation - II
- Lecture 6 - Modal Analysis - I
- Lecture 7 - Modal Analysis - II
- Lecture 8 - Properties of the Eigenvalue Problem
- Lecture 9 - Modal Analysis: Approximate Methods - I
- Lecture 10 - Modal Analysis: Approximate Methods - II
- Lecture 11 - The Initial Value Problem
- Lecture 12 - Forced Vibration Analysis - I
- Lecture 13 - Forced Vibration Analysis - II
- Lecture 14 - Forced Vibration Analysis - III
- Lecture 15 - Damping in Structures
- Lecture 16 - Axially Translating Strings
- Lecture 17 - d' Alembert's Solution - I
- Lecture 18 - d' Alembert's Solution - II
- Lecture 19 - Harmonic Waves and Energetics of Wave Motion
- Lecture 20 - Scattering of Waves
- Lecture 21 - Applications of Wave Solution - I
- Lecture 22 - Applications of Wave Solution - II
- Lecture 23 - Beam Models - I
- Lecture 24 - Beam Models - II
- Lecture 25 - Modal Analysis of Beams
- Lecture 26 - Applications of Modal Solution
- Lecture 27 - Approximate Methods
- Lecture 28 - Topic in Beam Vibration - I
- Lecture 29 - Topic in Beam Vibration - II
- Lecture 30 - Wave Propagation in Beams
- Lecture 31 - Dynamics of Curved Beams

[Lecture 32 - Vibrations of Rings and Arches](#)

[Lecture 33 - Dynamics of Membranes](#)

[Lecture 34 - Vibrations of Rectangular Membrane](#)

[Lecture 35 - Vibrations of Circular Membrane](#)

[Lecture 36 - Special Problems in Membrane Vibrations](#)

[Lecture 37 - Dynamics of Plates](#)

[Lecture 38 - Vibrations of Rectangular Plates](#)

[Lecture 39 - Vibrations of Circular Plates](#)

[Lecture 40 - Special Problems in Plate Vibrations](#)

- Lecture 1 - Introduction and Fundamental Concepts
- Lecture 2 - Zeroth Law and Fundamental Concepts
- Lecture 3 - Different Kind of Energy and First Law - I
- Lecture 4 - First Law - II
- Lecture 5 - First Law - III
- Lecture 6 - Second Law and Its Corollaries - I
- Lecture 7 - Second Law and Its Corollaries - II
- Lecture 8 - Second Law and Its Corollaries - III
- Lecture 9 - Second Law and Its Corollaries - IV
- Lecture 10 - Second Law and Available Energy - I
- Lecture 11 - Second Law and Available Energy - II
- Lecture 12 - Second Law and Available Energy - III
- Lecture 13 - Thermodynamic Property Relations - I
- Lecture 14 - Thermodynamic Property Relations - II
- Lecture 15 - Joule-Kelvin Expansion: Properties of Pure Substances
- Lecture 16 - Properties of Pure Substances - I
- Lecture 17 - Properties of Pure Substances - II
- Lecture 18 - Properties of Pure Substances: Ideal Gases
- Lecture 19 - Properties of Ideal Gases
- Lecture 20 - Vapors Power Cycle - I
- Lecture 21 - Vapor Power Cycle - II
- Lecture 22 - Vapor Power Cycle - III
- Lecture 23 - Vapor Power Cycle - IV
- Lecture 24 - Gas Power Cycle - I
- Lecture 25 - Gas Power Cycle - II
- Lecture 26 - Gas Power Cycle - III
- Lecture 27 - Thermodynamics of Reacting System - I
- Lecture 28 - Thermodynamics of Reacting System - II
- Lecture 29 - Thermodynamics of Reacting System - III
- Lecture 30 - Thermodynamics of Multi Component System - I
- Lecture 31 - Thermodynamics of Multi Component System - II



Lecture 1 - Design Philosophy

Lecture 2 - Design And Manufacturing

Lecture 3 - Engineering Materials

Lecture 4 - Engineering Materials

Lecture 5 - Simple Stresses In Machine Elements

Lecture 6 - Simple Stresses In Machine Elements

Lecture 7 - Compound Stresses In Machine Elements

Lecture 8 - Design For Strength

Lecture 9 - Design for Strength

Lecture 10 - Design For Strength

Lecture 11 - Design for Strength

Lecture 12 - Design for Strength

Lecture 13 - Design of Fasteners - I

Lecture 14 - Design of Fasteners - II

Lecture 15 - Design Of Keys and Splines

Lecture 16 - Threaded Fasteners

Lecture 17 - Design Of Threaded Fasteners

Lecture 18 - Power Screws

Lecture 19 - Design Of Power Screws

Lecture 20 - Shaft Coupling - I

Lecture 21 - Shaft Coupling - II

Lecture 22 - Rivet Joints

Lecture 23 - Design of Welded Joints - I

Lecture 24 - Design of Welded Joints - II

Lecture 25 - Design of Joints With Eccentric Loading

Lecture 26 - Design of Joints With Variable Loading

Lecture 27 - Design of Springs

Lecture 28 - Design Of Springs

Lecture 29 - Design Of Springs

Lecture 30 - Belt Drives

Lecture 31 - Belt Drives

[Lecture 32 - Belt Drives](#)

[Lecture 33 - Design for Strength](#)

[Lecture 34 - Design of Shafts](#)

[Lecture 35 - Design of Machine Elements - I \(V & W\)](#)

[Lecture 36 - Design of Machine Elements - II \(V & W\)](#)

[Lecture 37 - Design of Cylinders & Pressure Vessels - II](#)

[Lecture 38 - Design of Cylinders & Pressure Vessels - III](#)

[Lecture 39 - Design of Brakes - I](#)

[Lecture 40 - Design of Brakes - II](#)

**NPTEL : Manufacturing Processes II (Mechanical Engineering)**

**Co-ordinators : Prof. S. Paul, Prof. A.B. Chattopadhyay, Prof. A.K. Chattopadhyay**

Lecture 1 - Instructional Objectives - I (Manufacturing Process II)

Lecture 2 - Instructional Objectives - II

Lecture 3 - On Tool Geometry

Lecture 4 - Interrelations Among The Tool Angles

Lecture 5 - Mechanism of Chip Formation

Lecture 6 - Orthogonal and Oblique Cutting

Lecture 7 - Use of Chip Breaker in Machining

Lecture 8 - Machining Forces

Lecture 9 - Analytical and Experimental

Lecture 10 - Dynamometers for Measuring Cutting Forces

Lecture 11 - CTCEAC

Lecture 12 - CCTCFA

Lecture 13 - Concept of Machinability and its Improvement

Lecture 14 - Tool Life

Lecture 15 - Conventional Cutting Tool Maths

Lecture 16 - Advanced Tool Materials

Lecture 17 - Kinematics System of Centre Lathe

Lecture 18 - General Purpose Machine Tool Drills

Lecture 19 - Kinematic Systems and Operations

Lecture 20 - Configuration and Kinematic System

Lecture 21 - Mounting of jobs and Cutting Tools in Machine

Lecture 22 - Mounting of jobs and Cutting Tools in Machine

Lecture 23 - Construction, Operation and Tool Layout

Lecture 24 - Use of Attachments In Machine Tools

Lecture 25 - Forces Developing and Acting In Machine Tools

Lecture 26 - Estimation of Machining Time

Lecture 27 - Broaching - Principle Systems and Applications

Lecture 28 - Grinding Principle and Application

Lecture 29 - Abrasive Processes

Lecture 30 - Abrasive Processes (Grinding)

Lecture 31 - Super finishing Processes

[Lecture 32 - Production of Screw Threads](#)

[Lecture 33 - Gear Manufacturing](#)

[Lecture 34 - Jigs and Fixtures For Machine Shops](#)

[Lecture 35 - Design and Applications of Jigs and Fixtures](#)

[Lecture 36 - Non Traditional Manufacturing](#)

[Lecture 37 - Ultrasonic Machining](#)

[Lecture 38 - Water Jet Machining and Abrasive Water Jet](#)

[Lecture 39 - Electro - Chemical Machining](#)

[Lecture 40 - Electro - Discharge Machining](#)

[Lecture 41 - EBM and LBM](#)



**NPTEL : Refrigeration and Air Conditioning (Mechanical Engineering)**

**Co-ordinators : Prof. M. Ramgopal, Prof. R.C. Arora**

Lecture 1 - History of Refrigeration

Lecture 2 - Refrigerant Compressors & Development

Lecture 3 - Applications of RTAC

Lecture 4 - Review of Fundamentals Thermodynamics - I

Lecture 5 - Review of Fundamentals

Lecture 6 - Fundamentals of Fluid Flow

Lecture 7 - Fundamentals of Heat Transfer

Lecture 8 - Methods of Producing low Temperatures

Lecture 9 - Air Cycle Refrigeration Systems

Lecture 10 - Vapour Compression Refrigeration Systems

Lecture 11 - Vapour Compression Refrigeration Systems (Continued...)

Lecture 12 - Vapour Compression Refrigeration Systems (Continued...)

Lecture 13 - Vapour Compression Refrigeration Systems (Continued...)

Lecture 14 - Vapour Absorption Refrigeration Systems

Lecture 15 - Vapour Absorption Refrigeration System

Lecture 16 - Vapour Absorption Refrigeration Systems (Continued...)

Lecture 17 - Vapour Absorption Refrigeration Systems (Continued...)

Lecture 18 - Worked Out Examples - I

Lecture 19 - Worked Out Examples - II

Lecture 20 - Refrigeration System Components : Compressor

Lecture 21 - Refrigeration System Components : Compressor (Continued...)

Lecture 22 - Refrigeration System Components : Compressor (Continued...)

Lecture 23 - Refrigeration System Components : Compressor (Continued...)

Lecture 24 - Refrigeration System Components : Compressor (Continued...)

Lecture 25 - Refrigeration System Components : Compressor (Continued...)

Lecture 26 - Refrigeration System Components : Condensers

Lecture 27 - Refrigeration System Components : Condensers (Continued...)

Lecture 28 - Refrigeration System Components : Evaporators

Lecture 29 - Refrigeration System Components : Evaporators

Lecture 30 - Refrigeration System Components : Expansion Devices

Lecture 31 - Refrigeration System Components : Expansion Devices

- [Lecture 32 - Analysis of Complete Vapour Compression System](#)
- [Lecture 33 - Refrigerants](#)
- [Lecture 34 - Psychrometry](#)
- [Lecture 35 - Psychrometric Processes](#)
- [Lecture 36 - Inside Design Condition Thermal Comfort](#)
- [Lecture 37 - Psychrometry of Air Conditioning Systems](#)
- [Lecture 38 - Air Conditioning Systems](#)
- [Lecture 39 - Cooling and Heating Load Calculation : Solar Radiation](#)
- [Lecture 40 - Cooling and Heating Load Calculations](#)
- [Lecture 41 - Cooling and Heating Load Calculations \(Continued...\)](#)
- [Lecture 42 - Cooling and Heating Load Calculations \(Continued...\)](#)
- [Lecture 43 - Selection of Air Conditioning Systems](#)
- [Lecture 44 - Transmission and Distribution of Air](#)
- [Lecture 45 - Transmission and Distribution of Air \(Continued..\)](#)
- [Lecture 46 - Space Air Distribution](#)

**NPTEL : Fluid Mechanics (Mechanical Engineering)**

**Co-ordinators : Prof. S.K. Som**

Lecture 1 - Introduction and Fundamental Concepts - Part I

Lecture 2 - Introduction and Fundamental Concepts - Part II

Lecture 3 - Introduction and Fundamental Concepts - Part III

Lecture 4 - Fluid Statics - Part I

Lecture 5 - Fluid Statics - Part II

Lecture 6 - Fluid Statics - Part III

Lecture 7 - Fluid Statics - Part IV

Lecture 8 - Fluid Statics - Part V

Lecture 9 - Fluid Statics - Part VI

Lecture 10 - Kinematics of Fluid - Part I

Lecture 11 - Kinematics of Fluid - Part II

Lecture 12 - Kinematics of Fluid - Part III

Lecture 13 - Conservation Equations in Fluid Flow - Part I

Lecture 14 - Conservation Equations in Fluid Flow - Part II

Lecture 15 - Conservation Equations in Fluid Flow - Part III

Lecture 16 - Conservation Equations in Fluid Flow - Part IV

Lecture 17 - Conservation Equations in Fluid Flow - Part V

Lecture 18 - Conservation Equations in Fluid Flow - Part VI

Lecture 19 - Conservation Equations in Fluid Flow - Part VII

Lecture 20 - Conservation Equations in Fluid Flow - Part VIII

Lecture 21 - Conservation Equations in Fluid Flow - Part IX

Lecture 22 - Fluid Flow Applications - Part I

Lecture 23 - Fluid Flow Applications - Part II

Lecture 24 - Fluid Flow Applications - Part III

Lecture 25 - Fluid Flow Applications - Part IV

Lecture 26 - Fluid Flow Applications - Part V

Lecture 27 - Fluid Flow Applications - Part VI

Lecture 28 - Fluid Flow Applications - Part VII

Lecture 29 - Incompressible Viscous Flows - Part I

Lecture 30 - Incompressible Viscous Flows - Part II

Lecture 31 - Incompressible Viscous Flows - Part III

- [Lecture 32 - Incompressible Viscous Flows - Part IV](#)
- [Lecture 33 - Application of ViscousFlow Through Pipes - Part I](#)
- [Lecture 34 - Application of ViscousFlow Through Pipes - Part II](#)
- [Lecture 35 - Application of ViscousFlow Through Pipes - Part III](#)
- [Lecture 36 - Principles of Similarity - Part I](#)
- [Lecture 37 - Principles of Similarity - Part II](#)
- [Lecture 38 - Principles of Similarity - Part III](#)
- [Lecture 39 - Flow of Ideal Fluids - Part I](#)
- [Lecture 40 - Flow of Ideal Fluids - Part II](#)
- [Lecture 41 - Flows with a Free Surface - Part I](#)
- [Lecture 42 - Flows with a Free Surface - Part II](#)
- [Lecture 43 - Flows with a Free Surface - Part III](#)
- [Lecture 44 - A Few Unsteady Flow Phenomena in Practice - Part I](#)
- [Lecture 45 - A Few Unsteady Flow Phenomena in Practice - Part II](#)
- [Lecture 46 - Introduction to Laminar Boundary Layer - Part I](#)
- [Lecture 47 - Introduction to Laminar Boundary Layer - Part II](#)
- [Lecture 48 - Introduction to Turbulent Flow - Part I](#)
- [Lecture 49 - Introduction to Turbulent Flow - Part II](#)

Lecture 1 - Introduction to Fluid Machines I

Lecture 2 - Energy Transfer in Fluid Machines Part - I

Lecture 3 - Energy Transfer in Fluid Machines Part - II

Lecture 4 - Energy Transfer - impulse and Reaction Machines, efficiencies of Fluid Machines

Lecture 5 - Principles of Similarity in Fluid Machines

Lecture 6 - Concept of specific speed and introduction to Impulse Hydraulic Turbine

Lecture 7 - Analysis of force on the Bucket of Pelton wheel and Power Generation

Lecture 8 - Specific speed, Governing and Limitation of a Pelton Turbine

Lecture 9 - Introduction to reaction Type of Hydraulic Turbine - A Francis Turbine

Lecture 10 - Analysis of Force on Francis Runner and Power Generation

Lecture 11 - Axial Flow Machine and Draft Tube

Lecture 12 - Governing of Reaction Turbine

Lecture 13 - Introduction to Rotodynamic Pumps

Lecture 14 - Flow and Energy Transfer in a Centrifugal Pump

Lecture 15 - Characteristics of a Centrifugal Pump

Lecture 16 - Matching of Pump and System Characteristics

Lecture 17 - Diffuser and Cavitation

Lecture 18 - Axial Flow Pump

Lecture 19 - Reciprocating Pump - Part I

Lecture 20 - Reciprocating Pump - Part II

Lecture 21 - Centrifugal Compressor - Part I

Lecture 22 - Centrifugal Compressor - Part II

Lecture 23 - Centrifugal Compressor - Part III

Lecture 24 - Axial Flow Compressor - Part I

Lecture 25 - Axial Flow Compressor - Part II

Lecture 26 - Introduction to Compressible Flow - Part I

Lecture 27 - Introduction to Compressible Flow - Part II

Lecture 28 - Thermodynamic Relations and Speed of Sound

Lecture 29 - Disturbance propagation, Stagnation and Sonic Properties

Lecture 30 - Effects of Area Variation on Properties in an Isentropic Flow

Lecture 31 - Choking in a Converging Nozzle

[Lecture 32 - Isentropic Flow through Convergent - Divergent Duct](#)

[Lecture 33 - Normal Shock - Part I](#)

[Lecture 34 - Normal Shock - Part II](#)

[Lecture 35 - Normal Shock - Part III](#)

[Lecture 36 - Normal Shock - Part IV](#)

[Lecture 37 - Normal Shock - Part V](#)

[Lecture 38 - Oblique Shock - Part I](#)

[Lecture 39 - Oblique Shock - Part II](#)

[Lecture 40 - Introduction to Expansion Wave and Prandtl Meyer Flow](#)

[Lecture 1 - Introductory Concepts](#)

[Lecture 2 - Introductory Concepts \(Continued...\)](#)

[Lecture 3 - Introductory Concepts \(Continued...\)](#)

[Lecture 4 - Viscosity](#)

[Lecture 5 - Viscosity \(Continued...\)](#)

[Lecture 6 - Viscosity \(Continued...\) and Surface Tension](#)

[Lecture 7 - Surface Tension \(Continued...\) and Fluid Statics](#)

[Lecture 8 - Fluid Statics \(Continued...\)](#)

[Lecture 9 - Fluid Statics \(Continued...\)](#)

[Lecture 10 - Fluid Statics \(Continued...\) and Fluid Under Rigid Body Motion](#)

[Lecture 11 - Fluid Kinematics](#)

[Lecture 12 - Fluid Kinematics \(Continued...\)](#)

[Lecture 13 - Fluid Kinematics \(Continued...\)](#)

[Lecture 14 - Fluid Kinematics \(Continued...\)](#)

[Lecture 15 - Fluid Kinematics \(Continued...\)](#)

[Lecture 16 - Dynamics of Inviscid Flows](#)

[Lecture 17 - Dynamics of Inviscid Flows \(Continued...\)](#)

[Lecture 18 - Dynamics of Inviscid Flows \(Continued...\)](#)

[Lecture 19 - Dynamics of Inviscid Flows \(Continued...\)](#)

[Lecture 20 - Dynamics of Inviscid Flows \(Continued...\)](#)

[Lecture 21 - Integral Forms of Control Volume Conservation Equations \(Reynolds Transport Theorem\)](#)

[Lecture 22 - Integral Forms of Control Volume Conservation Equations \(Reynolds Transport Theorem\) \(Continued...\)](#)

[Lecture 23 - Integral Forms of Control Volume Conservation Equations \(Reynolds Transport Theorem\) \(Continued...\)](#)

[Lecture 24 - Integral Forms of Control Volume Conservation Equations \(Reynolds Transport Theorem\) \(Continued...\)](#)

[Lecture 25 - Integral Forms of Control Volume Conservation Equations \(Reynolds Transport Theorem\) \(Continued...\)](#)

[Lecture 26 - Integral Forms of Control Volume Conservation Equations \(Reynolds Transport Theorem\) \(Continued...\)](#)

[Lecture 27 - Integral Forms of Control Volume Conservation Equations \(Reynolds Transport Theorem\) \(Continued...\)](#)

[Lecture 28 - Dynamics of Viscous Flows : Navier Stokes Equation](#)

[Lecture 29 - Dynamics of Viscous Flows : Navier Stokes Equation \(Continued...\)](#)

[Lecture 30 - Some Exact Solutions of Navier Stokes Equation](#)

[Lecture 31 - Some Exact Solutions of Navier Stokes Equation \(Continued...\)](#)

- [Lecture 32 - Some Exact Solutions of Navier Stokes Equation \(Continued...\)](#)
- [Lecture 33 - Introduction to Turbulence](#)
- [Lecture 34 - Introduction to Turbulence \(Continued...\)](#)
- [Lecture 35 - Introduction to Turbulence \(Continued...\)](#)
- [Lecture 36 - Introduction to Turbulence \(Continued...\)](#)
- [Lecture 37 - Boundary Layer Theory](#)
- [Lecture 38 - Boundary Layer Theory \(Continued...\)](#)
- [Lecture 39 - Boundary Layer Theory \(Continued...\)](#)
- [Lecture 40 - Boundary Layer Theory \(Continued...\) and Flow Past Immersed Bodies](#)
- [Lecture 41 - Flow past Immersed Bodies \(Continued...\)](#)
- [Lecture 42 - Potential Flow Past Immersed Bodies](#)
- [Lecture 43 - Potential Flow \(Continued...\) and Flow Past Immersed Bodies of Special Shapes](#)
- [Lecture 44 - Flow Past Immersed Bodies \(Continued...\) and Sports Ball Aerodynamics](#)
- [Lecture 45 - Pipe Flow](#)
- [Lecture 46 - Pipe Flow \(Continued...\)](#)
- [Lecture 47 - Pipe Flow \(Continued...\)](#)
- [Lecture 48 - Principles of Similarity and Dimensional Analysis](#)
- [Lecture 49 - Introduction to Fluid Machines](#)
- [Lecture 50 - Introduction to Fluid Machines \(Continued...\)](#)
- [Lecture 51 - Introduction to Fluid Machines \(Continued...\)](#)
- [Lecture 52 - Introduction to Fluid Machines \(Continued...\)](#)
- [Lecture 53 - Introduction to Fluid Machines \(Continued...\)](#)
- [Lecture 54 - Compressible Flows](#)
- [Lecture 55 - Compressible Flows \(Continued...\)](#)
- [Lecture 56 - Compressible Flows \(Continued...\)](#)
- [Lecture 57 - Compressible Flows \(Continued...\)](#)
- [Lecture 58 - Compressible Flows \(Continued...\)](#)



**NPTEL : Micro fluidics (Mechanical Engineering)**

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

Lecture 1 - Introduction to Microfluidics

Lecture 2 - Microfluidics: Some Application Examples

Lecture 3 - Microfluidics: Some More Application Examples

Lecture 4 - Equations of Conservation

Lecture 5 - Navier Stokes Equation

Lecture 6 - Navier Stokes Equation (Continued...)

Lecture 7 - Energy Equation

Lecture 8 - Energy Equation (Continued...) and Species Conservation Equation

Lecture 9 - Pressure-driven Microflows

Lecture 10 - Pressure-driven Microflows (Continued...)

Lecture 11 - Pressure-driven Microflows (Continued...)

Lecture 12 - Pressure-driven Microflows (Continued...)

Lecture 13 - Pressure -driven Microflows (Continued...)

Lecture 14 - Some Examples of Unsteady Flows

Lecture 15 - Some Examples of Unsteady Flows (Continued...)

Lecture 16 - Some Examples of Unsteady Flows (Continued...)

Lecture 17 - Stokes Drag on a Sphere

Lecture 18 - Stokes Drag on a Sphere (Continued...) and Introduction to Lubrication Theory

Lecture 19 - Lubrication Theory (Continued...)

Lecture 20 - Lubrication Theory (Continued...)

Lecture 21 - Boundary Condition in Fluid Mechanics: Slip or No-slip?

Lecture 22 - Boundary Condition in Fluid Mechanics: Slip or No-slip? (Continued...)

Lecture 23 - Surface Tension Driven Flows

Lecture 24 - Surface Tension Driven Flows (Continued...)

Lecture 25 - Surface Tension Driven Flows (Continued...)

Lecture 26 - Surface Tension Driven Flows (Continued...)

Lecture 27 - Surface Tension Driven Flows (Continued...) and Modulating Surface Tension

Lecture 28 - Modulating Surface Tension (Continued...)

Lecture 29 - Thin Film Dynamics

Lecture 30 - Thin Film Dynamics (Continued...)

Lecture 31 - Thin Film Dynamics (Continued...)

[Lecture 32 - Thin Film Dynamics \(Continued...\)](#)

[Lecture 33 - Lab on a CD](#)

[Lecture 34 - Lab on a CD \(Continued...\)](#)

[Lecture 35 - Introduction to Microfabrication](#)

[Lecture 36 - Electrokinetics](#)

[Lecture 37 - Electrokinetics \(Continued...\)](#)

[Lecture 38 - Electrokinetics \(Continued...\)](#)

[Lecture 39 - Electrokinetics \(Continued...\)](#)

[Lecture 40 - Electrokinetics \(Continued...\)](#)

[Lecture 41 - Electrokinetics \(Continued...\)](#)

[Lecture 42 - Dispersion](#)

[Lecture 43 - Introduction to Nanofluidics](#)

[Lecture 44 - Introduction to Nanofluidics \(Continued...\) and Molecular Dynamics Simulations](#)

[Lecture 45 - Introduction to Molecular Dynamics Simulations \(Continued...\)](#)

[Lecture 46 - Biomicrofluidics](#)

[Lecture 47 - Biomicrofluidics \(Continued...\)](#)

[Lecture 48 - Nanofluidic Energy Conversion](#)

Lecture 1 - Introduction and Fundamental Concepts - I

Lecture 2 - Introduction and Fundamental Concepts - II

Lecture 3 - Heat Conduction Equation

Lecture 4 - Heat Conduction Equation and Different Types of Boundary Conditions

Lecture 5 - 1D Steady State Heat Conduction In Plane Wall Without Generation of Thermal Energy

Lecture 6 - 1D Steady State Heat Conduction In Plane Wall With Generation of Thermal Energy

Lecture 7 - Problems on 1D Steady State Heat Conduction In Plane Wall

Lecture 8 - 1D Steady State Heat Conduction In Cylindrical Geometry

Lecture 9 - 1D Steady State Heat Conduction In Cylindrical Geometry (Continued...)

Lecture 10 - 1D Steady State Heat Conduction in Spherical Geometry

Lecture 11 - Heat Transfer from Extended Surfaces (Fins)

Lecture 12 - Heat Transfer from Extended Surfaces (Continued...)

Lecture 13 - Two-dimensional Steady State Heat Conduction

Lecture 14 - Unsteady State Heat Conduction

Lecture 15 - Unsteady State Heat Conduction (Continued...)

Lecture 16 - One Dimensional Unsteady State Heat Conduction - I

Lecture 17 - One Dimensional Unsteady State Heat Conduction - II

Lecture 18 - Introduction to Convection

Lecture 19 - Convection - I

Lecture 20 - Review of Fluid Mechanics - I

Lecture 21 - Review of Fluid Mechanics - II

Lecture 22 - Review of Fluid Mechanics - III

Lecture 23 - Review of Fluid Mechanics - IV

Lecture 24 - Review of Fluid Mechanics - V

Lecture 25 - Review of Fluid Mechanics - VI

Lecture 26 - Review of Fluid Mechanics - VIII

Lecture 27 - Energy Equation - I

Lecture 28 - Energy Equation - II and Thermal Boundary Layer - I

Lecture 29 - Thermal Boundary Layer - II

Lecture 30 - Integral Method for Thermal BL Analysis

Lecture 31 - Internal Forced Convection - I

[Lecture 32 - Internal Forced Convection - II](#)

[Lecture 33 - Internal Forced Convection - III](#)

[Lecture 34 - Internal Forced Convection - IV](#)

[Lecture 35 - Free Convection - I \(Natural Convection\)](#)

[Lecture 36 - Free Convection - II \(Natural Convection\)](#)

[Lecture 37 - Boiling and Condensation - I](#)

[Lecture 38 - Boiling and Condensation - II](#)

[Lecture 39 - Heat Exchanger - I](#)

[Lecture 40 - Heat Exchanger - II](#)

[Lecture 41 - Heat Exchanger - II \(Continued...\)](#)

- Lecture 1 - Transverse Vibrations of Strings - I
- Lecture 2 - Transverse Vibrations of Strings - II
- Lecture 3 - Axial and Torsional Vibrations of Bars
- Lecture 4 - Variational Formulation - I
- Lecture 5 - Variational Formulation - II
- Lecture 6 - Modal Analysis - I
- Lecture 7 - Modal Analysis - II
- Lecture 8 - Properties of the Eigenvalue Problem
- Lecture 9 - Modal Analysis: Approximate Methods - I
- Lecture 10 - Modal Analysis: Approximate Methods - II
- Lecture 11 - The Initial Value Problem
- Lecture 12 - Forced Vibration Analysis - I
- Lecture 13 - Forced Vibration Analysis - II
- Lecture 14 - Forced Vibration Analysis - III
- Lecture 15 - Damping in Structures - I
- Lecture 16 - Damping in Structures - II
- Lecture 17 - Beam Models - I
- Lecture 18 - Beam Models - II
- Lecture 19 - Modal Analysis of Beams
- Lecture 20 - Application of Modal Solution
- Lecture 21 - Approximate Methods
- Lecture 22 - Topics in Beam Vibrations - I
- Lecture 23 - Topics in Beam Vibrations - II
- Lecture 24 - Dynamics of Curved Beams
- Lecture 25 - Vibrations of Rings and Arches - I
- Lecture 26 - Vibrations of Rings and Arches - II
- Lecture 27 - Dynamics of Membranes
- Lecture 28 - Vibrations of Rectangular Membranes
- Lecture 29 - Vibrations of Circular Membranes - I
- Lecture 30 - Vibrations of Circular Membranes - II
- Lecture 31 - Dynamics of Plates

[Lecture 32 - Vibrations of Rectangular Plates](#)

[Lecture 33 - Vibrations of Circular Plates](#)

[Lecture 34 - Special Problems in Plate Vibrations - I](#)

[Lecture 35 - Special Problems in Plate Vibrations - II](#)

**NPTEL : NOC:Fluid Machines (Mechanical Engineering)**

**Co-ordinators : Prof. S.K. Som**

Lecture 1 - Definition of Fluid Machines and Energy Transfer in Fluid Machines - Part I

Lecture 2 - Energy Transfer in Fluid Machines - Part II

Lecture 3 - Impulse and Reaction Machines: Introductory Concepts

Lecture 4 - Principles of Similarity in Fluid Machine

Lecture 5 - Concept of Specific Speed

Lecture 6 - Basic Principles, Analysis of Force and Power Generation - Part I

Lecture 7 - Basic Principles, Analysis of Force and Power Generation - Part II

Lecture 8 - Specific Speed Governing and Limitations of Impulse Turbine

Lecture 9 - Tutorial - I

Lecture 10 - Tutorial - II

Lecture 11 - Introduction and Analysis of Force on Francis Turbine (Radial Flow) - Part I

Lecture 12 - Analysis of Force (Part-II) and Power Generation

Lecture 13 - Draft Tube

Lecture 14 - Tutorial - III

Lecture 15 - Tutorial - IV

Lecture 16 - Axial Flow Turbine

Lecture 17 - Governing of Reaction Turbine

Lecture 18 - Introduction to Rotodynamic Pumps

Lecture 19 - Flow and Energy Transfer to Centrifugal Pumps

Lecture 20 - Tutorial - V

Lecture 21 - Characteristics of a Centrifugal Pump

Lecture 22 - Matching of Pump and System Characteristics

Lecture 23 - Diffuser and Cavitation

Lecture 24 - Tutorial - VI

Lecture 25 - Tutorial - VIII

Lecture 26 - Axial Flow Pump

Lecture 27 - Reciprocating Pump - Part I

Lecture 28 - Reciprocating Pump - Part II

Lecture 29 - Tutorial - VIII

Lecture 30 - Basic Principles and Energy Transfer in Centrifugal Compressor - Part I

Lecture 31 - Basic Principles and Energy Transfer in Centrifugal Compressor - Part II

[Lecture 32 - Basic Principles and Energy Transfer in Centrifugal Compressor - Part III](#)

[Lecture 33 - Basic Principles and Energy Transfer in Centrifugal Compressor - Part IV and Losses in Centrifugal Compressors](#)

[Lecture 34 - Performance Characteristics of Centrifugal Compressors - Part I](#)

[Lecture 35 - Performance Characteristics of Centrifugal Compressors - Part II](#)

[Lecture 36 - Basic Principles and Energy Transfer in Axial Flow Compressor - Part I](#)

[Lecture 37 - Basic Principles and Energy Transfer in Axial Flow Compressor - Part II](#)

[Lecture 38 - Fans and Blowers - Part I](#)

[Lecture 39 - Fans and Blowers - Part II](#)



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

**NPTEL : NOC:Computer numerical control (CNC) of machine tools and processes (Mechanical Engineering)**

**Co-ordinators : Prof. Asimava Roy Choudhury**

Lecture 1 - Introduction to computer control – role of computers in automation

Lecture 2 - Introduction (Continued...) - binary logic and logic gates

Lecture 3 - Classification of Computer numerical control (CNC) – Point to point and continuous control

Lecture 4 - Classification (Continued...) - Closed loop and open loop control

Lecture 5 - Tutorial involving simple calculations on different aspects of CNC controls

Lecture 6 - Questions, MCQ Discussions on Motors, Encoders, Decoders and Programming Practice

Lecture 7 - Stepper motors, Permanent magnet DC motors

Lecture 8 - Binary circuits and decoders

Lecture 9 - Tachogenerator, printed circuit motors, Encoders

Lecture 10 - Programming Practice - I

Lecture 11 - Programming Practice - II

Lecture 12 - Computer Aided Offline Programming

Lecture 13 - Interpolators - Linear

Lecture 14 - Interpolators - Curvilinear

Lecture 15 - Questions on Programming and Interpolation

Lecture 16 - 3-D Machining - Basic Concepts

Lecture 17 - Curved Surface Geometry

Lecture 18 - Cutter Path Generation for Curved Surfaces

Lecture 19 - Cutter Path Generation (Concluding Part) and Current Status - CNC Machining and Related Processes

Lecture 20 - Questions and Discussions on Curved Surface Machining

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

## **NPTEL : NOC:Non Traditional Abrasive Machining Processes - Ultrasonic, Abrasive Jet and Abrasive Water Jet Machining (Mechanical Engineering)**

**Co-ordinators : Prof. Asimava Roy Choudhury**

Lecture 1 - Non-traditional abrasive machining : Ultrasonic, Abrasive jet and abrasive water jet machining

Lecture 2 - Ultrasonic Machining

Lecture 3 - Ultrasonic Machining (Continued...)

Lecture 4 - Ultrasonic Machining - Free Impacts and Problem Solving

Lecture 5 - Ultrasonic Machining - Problems and MCQs

Lecture 6 - USM - Horn Design

Lecture 7 - USM - Horn Design (Continued...)

Lecture 8 - Ultrasonic Machining - Feed Mechanism, Head design and other aspects

Lecture 9 - Ultrasonic Machining - Effects of Various Inputs on the Output

Lecture 10 - Ultrasonic Machining - Numerical and MCQs

Lecture 11 - A JM (Abrasive jet machining)

Lecture 12

Lecture 13 - A JM - Numerical problems

Lecture 14 - A JM - Process Parameters and Response Characteristics take - home assignment discussing

Lecture 15 - A JM - MCQs

Lecture 16

Lecture 17 - AWJM - Equipment

Lecture 18 - AWJM - Numerical Problems

Lecture 19 - AWJM - Application Equipment Details

Lecture 20 - AWJM - MCQs

- Lecture 1 - Lagrangian and Eulerian Approach, Types of fluid flow
- Lecture 2 - Streamlines, Streakline and Pathline
- Lecture 3 - Acceleration of fluid flow
- Lecture 4 - Deformation and Conservation of mass of fluid a element
- Lecture 5 - Angular deformation of a fluid element, vorticity and streamfunction and velocity potential
- Lecture 6 - Euler's equation
- Lecture 7 - Bernoulli's Equation - Part I
- Lecture 8 - Bernoulli's Equation - Part II
- Lecture 9 - Reynolds Transport Theorem (RTT)
- Lecture 10 - Application of Conservation of Mass
- Lecture 11 - Application of RTT: Conservation of Linear Momentum
- Lecture 12 - Application of RTT in Accelerating Reference Frames
- Lecture 13 - Navier's Equation of Motion
- Lecture 14 - Derivation of Navier-Stokes Equation
- Lecture 15 - Derivation of Navier-Stokes Equation (Continued...)
- Lecture 16 - Derivation of Navier-Stokes Equation (Continued...)
- Lecture 17 - Fully developed flow between two parallel plates
- Lecture 18 - Force on a surface immersed in fluid - Part III, Stability of solid bodies in fluid - Part I
- Lecture 19 - Couette flow
- Lecture 20 - Flow with interfaces
- Lecture 21 - Thin film flow on an inclined plane and Hagen-Poiseuille flow
- Lecture 22 - Hagen-Poiseuille flow (Continued...)
- Lecture 23 - Flow between two rotating cylinders
- Lecture 24 - Stokes 1st problem
- Lecture 25 - Stokes 2nd problem
- Lecture 26 - Introduction to turbulence: basic concepts
- Lecture 27 - Eddies
- Lecture 28 - Eddies (Continued...) and Vortex shredding
- Lecture 29 - Statistical description of turbulent flows
- Lecture 30 - Reynolds stress
- Lecture 31 - Reynolds averaged Navier Stokes equation (RANS)

- Lecture 32 - Bernoulli's equation - Part I
- Lecture 33 - Bernoulli's equation - Part II
- Lecture 34 - Bernoulli's equation - Part III
- Lecture 35 - Euler's equation in streamline coordinates
- Lecture 36 - Flow over a flat plate: Blasius equation
- Lecture 37 - Momentum integral method for boundary layer analysis
- Lecture 38 - Approximate solution of the momentum integral equation
- Lecture 39 - Displacement and Momentum thickness
- Lecture 40 - Illustrative examples
- Lecture 41 - Boundary layer separation
- Lecture 42 - Resultant force on a body immersed in a fluid under motion
- Lecture 43 - Potential flow
- Lecture 44 - Examples of Potential flow
- Lecture 45 - Some more examples of Potential flows, Lift and Drag force
- Lecture 46 - Applications of lift and drag force
- Lecture 47 - Some examples of flow past immersed bodies
- Lecture 48 - Sports Ball aerodynamics
- Lecture 49 - Introduction to compressible flows
- Lecture 50 - Significance of Mach number
- Lecture 51 - Navier-Stokes equation - Part I
- Lecture 52 - Navier-Stokes equation - Part II
- Lecture 53 - Navier-Stokes equation - Part III
- Lecture 54 - Navier-Stokes equation - Part IV
- Lecture 55 - Pipe Flow - Part I
- Lecture 56 - Pipe Flow - Part II
- Lecture 57 - Pipe Flow - Part III
- Lecture 58 - Pipe Flow - Part IV
- Lecture 59 - Principle of Similarity and Dynamical Analysis - Part I
- Lecture 60 - Principle of Similarity and Dynamical Analysis - Part II

Lecture 1 - Introduction

Lecture 2 - Simple Gear Calculations

Lecture 3 - Gear Geometry

Lecture 4 - Helical Gear Problems

Lecture 5 - Numerical Problem MCQ

Lecture 6 - Numerical Problem Milling of Helical Gears

Lecture 7 - Simple and Compound Indexing

Lecture 8 - Differential Indexing

Lecture 9 - Helical Gear Cutting on Milling Machine

Lecture 10 - Numerical Problems on Gear Milling

Lecture 11 - Gear Shaping - I

Lecture 12 - Gear Shaping - II

Lecture 13 - Gear Shaping - III

Lecture 14 - Gear Shaping - IV

Lecture 15 - Gear Hobbing - I

Lecture 16 - Gear Hobbing - II

Lecture 17 - Gear Hobbing - III

Lecture 18 - Gear Hobbing - IV

Lecture 19 - Gear Hobbing - V

Lecture 20 - Gear Hobbing - VI

- Lecture 1 - Introduction, Definition of System, Properties and State of a System
- Lecture 2 - Properties of pure substances
- Lecture 3 - Properties of pure substances (Continued...)
- Lecture 4 - Heat and Work
- Lecture 5 - Tutorial 1: Properties of pure substances, heat and work
- Lecture 6 - Zeroth Law of Thermodynamics
- Lecture 7 - First law of thermodynamics for closed systems - Part I
- Lecture 8 - First law of thermodynamics for closed systems - Part II, some examples
- Lecture 9 - Tutorial 2: First law of thermodynamics for closed systems
- Lecture 10 - First law of thermodynamics for open systems
- Lecture 11 - Tutorial 3: First law of thermodynamics for open systems
- Lecture 12 - Second law and its corollaries - Part I
- Lecture 13 - Second law and its corollaries - Part II
- Lecture 14 - Second law and its corollaries - Part III
- Lecture 15 - Definition of entropy and entropy change in closed systems
- Lecture 16 - Entropy change in closed systems (Continued...)
- Lecture 17 - Tutorial 4: Entropy
- Lecture 18 - Entropy and its transport
- Lecture 19 - Tutorial 5: Entropy and its transport
- Lecture 20 - Introduction to Third Law
- Lecture 21 - Review of learning concepts

Lecture 1 - Introduction to waste heat recovery

Lecture 2 - Introduction to waste heat recovery (Continued...)

Lecture 3 - Introduction to waste heat recovery (Continued...)

Lecture 4 - Introduction to waste heat recovery (Continued...)

Lecture 5 - Thermodynamic principles of waste heat recovery

Lecture 6 - Thermodynamic principles of waste heat recovery (Continued...)

Lecture 7 - Thermodynamic principles of waste heat recovery (Continued...)

Lecture 8 - Thermodynamic principles of waste heat recovery (Continued...)

Lecture 9 - Reversible Cycles

Lecture 10 - Reversible Cycles (Continued...)

Lecture 11 - Entropy

Lecture 12 - Entropy (Continued...)

Lecture 13 - Entropy (Continued...), Exergy

Lecture 14 - Exergy, Second Law efficiency

Lecture 15 - Second Law efficiency (Continued...)

Lecture 16 - Recapitulation of common power cycles

Lecture 17 - Recapitulation of common power cycles (Continued...)

Lecture 18 - Recapitulation of common power cycles (Continued...)

Lecture 19 - Recapitulation of common power cycles (Continued...)

Lecture 20 - Recapitulation of common power cycles (Continued...)

Lecture 21 - Recapitulation of common power cycles (Continued...)

Lecture 22 - Gas Turbine cycle

Lecture 23 - Combined cycle

Lecture 24 - Combined cycle (Continued...)

Lecture 25 - Combined Cycle (Continued...)

Lecture 26 - Heat recovery steam generator

Lecture 27 - Thermodynamic cycles for low temperature application

Lecture 28 - Thermodynamic cycles for low temperature application (Continued...), Cogeneration

Lecture 29 - Heat Exchanger

Lecture 30 - Heat Exchanger (Continued...)

Lecture 31 - Heat Exchanger (Continued...)

[Lecture 32](#)

[Lecture 33](#)

[Lecture 34](#)

[Lecture 35](#)

[Lecture 36](#)

[Lecture 37 - Heat Pipe - Part I](#)

[Lecture 38 - Heat Pipe - Part II](#)

[Lecture 39 - Heat Pipe - Part III](#)

[Lecture 40 - Direct Conversion - Introduction to TEG](#)

[Lecture 41 - Thermoelectric Generators - Functioning and Applications](#)

[Lecture 42 - TEG - performance analysis](#)

[Lecture 43 - TEG - performance optimization](#)

[Lecture 44 - Direct Conversion - Magneto Hydro dynamics \(MHD\)](#)

[Lecture 45 - Direct Conversion - Thermo-Ionic generation](#)

[Lecture 46 - Direct Conversion - Thermo Photo Voltaic generation \(TPV\)](#)

[Lecture 47 - Heat Pumps - I](#)

[Lecture 48 - Heat Pumps - II](#)

[Lecture 49 - Heat Pumps - III](#)

[Lecture 50 - Waste Heat Recovery from Incinerator Plants](#)

[Lecture 51 - Energy Storage Systems - I](#)

[Lecture 52 - Energy Storage Systems - II](#)

[Lecture 53 - Energy Storage Systems - III](#)

[Lecture 54 - Energy Storage Systems - IV](#)

[Lecture 55 - Energy Storage Systems - V](#)

[Lecture 56 - Energy Storage Systems - VI](#)

[Lecture 57](#)

[Lecture 58](#)

[Lecture 59](#)

[Lecture 60](#)

[Lecture 61](#)

[Lecture 62](#)

[Lecture 63](#)

[Lecture 64](#)



[Lecture 65](#)

[Lecture 66](#)

[Lecture 67](#)

[Lecture 68 - Corrigendum](#)

[Lecture 1 - Introduction](#)

[Lecture 2 - Introduction \(Continued...\)](#)

[Lecture 3 - Introduction \(Continued...\)](#)

[Lecture 4 - Introduction \(Continued...\)](#)

[Lecture 5 - Introduction \(Continued...\)](#)

[Lecture 6 - Introduction \(Continued...\)](#)

[Lecture 7 - Scaling Laws](#)

[Lecture 8 - Scaling laws \(Continued...\)](#)

[Lecture 9 - Scaling laws \(Continued...\)](#)

[Lecture 10 - Difference between macro and micro machining](#)

[Lecture 11 - Difference between macro and micro machining \(Continued...\)](#)

[Lecture 12 - Difference between micro and macro machining \(Continued...\)](#)

[Lecture 13 - Difference between micro and macro machining \(Continued...\)](#)

[Lecture 14 - Difference between macro and micro machining \(Continued...\)](#)

[Lecture 15 - Difference between macro and micro machining \(Continued...\)](#)

[Lecture 16 - Difference between macro and micro machining \(Continued...\)](#)

[Lecture 17 - Difference between macro and micro machining \(Continued...\)](#)

[Lecture 18 - Difference between macro and micro machining \(Continued...\)](#)

[Lecture 19 - Difference between macro and micro machining \(Continued...\)](#)

[Lecture 20 - Difference between macro and micro machining \(Continued...\)](#)

[Lecture 21 - Difference between macro and micro machining \(Continued...\)](#)

[Lecture 22 - Component of the machine tool](#)

[Lecture 23 - Components of the machine tool \(Continued...\)](#)

[Lecture 24 - Components of the machine tool \(Continued...\)](#)

[Lecture 25 - Components of the machine tool \(Continued...\)](#)

[Lecture 26 - Components of the machine tool \(Continued...\)](#)

[Lecture 27 - Errors in machine tool \(Continued...\)](#)

[Lecture 28 - Errors in machine tool \(Continued...\)](#)

[Lecture 29 - Errors in machine tool \(Continued...\)](#)

[Lecture 30 - Errors in machine tool \(Continued...\)](#)

[Lecture 31 - Components of machine tool](#)

- [Lecture 32 - Components of machine tool \(Continued...\)](#)
- [Lecture 33 - Components of machine tool \(Continued...\)](#)
- [Lecture 34 - Components of machine tool \(Continued...\)](#)
- [Lecture 35 - Components of machine tool \(Continued...\)](#)
- [Lecture 36 - Components of machine tool \(Continued...\)](#)
- [Lecture 37 - Components of machine tool \(Continued...\)](#)
- [Lecture 38 - Components of machine tool \(Continued...\)](#)
- [Lecture 39 - Components of machine tool \(Continued...\)](#)
- [Lecture 40 - Components of machine tool \(Continued...\)](#)
- [Lecture 41 - Components of machine tool \(Continued...\)](#)
- [Lecture 42 - Components of machine tool \(Continued...\)](#)
- [Lecture 43 - Components of machine tool \(Continued...\)](#)
- [Lecture 44 - Components of machine tool \(Continued...\)](#)
- [Lecture 45 - Components of machine tool \(Continued...\)](#)
- [Lecture 46 - Components of machine tool \(Continued...\)](#)
- [Lecture 47 - Components of machine tool \(Continued...\)](#)
- [Lecture 48 - Components of machine tool \(Continued...\)](#)
- [Lecture 49 - Micro tools](#)
- [Lecture 50 - Micro tools \(Continued...\)](#)
- [Lecture 51 - Micro tools \(Continued...\)](#)
- [Lecture 52 - Fabrication of micro tool by EDM process](#)
- [Lecture 53 - Micro tools \(Continued...\)](#)
- [Lecture 54 - Micro machines](#)
- [Lecture 55 - Micro machines \(Continued...\)](#)
- [Lecture 56 - Diamond turning](#)
- [Lecture 57 - Diamond turning \(Continued...\)](#)
- [Lecture 58 - Diamond turning \(Continued...\)](#)
- [Lecture 59 - Diamond turning \(Continued...\)](#)
- [Lecture 60 - Sensors and metrology for micro machining](#)
- [Lecture 61 - Sensors and metrology for micro machining \(Continued...\)](#)
- [Lecture 62 - Sensors and metrology for micro machining \(Continued...\)](#)
- [Lecture 63 - 3D surface measurement using interferometer](#)

Lecture 1 - Introduction

Lecture 2 - Maintenance Principles

Lecture 3 - FMECA

Lecture 4 - Fault Diagnostics and Prognostics

Lecture 5 - Machine Learning in CBM

Lecture 6 - Basics of Vibration

Lecture 7 - Free and Forced Response

Lecture 8 - Vibration and Shock Isolation

Lecture 9 - Rotordynamics

Lecture 10 - Practical Examples of Vibration

Lecture 11 - Time Domain Analysis

Lecture 12 - Frequency Domain Analysis

Lecture 13 - Non Stationary Signal Analysis

Lecture 14 - Modulation and Beats

Lecture 15 - Orbit and Order Analysis

Lecture 16 - Computer aided data acquisition

Lecture 17 - Orbit and Order Analysis

Lecture 18 - Data Recording

Lecture 19 - Cepstrum Analysis

Lecture 20 - Hilbert Transform in Condition Monitoring

Lecture 21 - Introduction to MATLAB

Lecture 22 - Signal Processing using MATLAB

Lecture 23 - Numericals in Signal Processing and Data Acquisition

Lecture 24 - Signal Hetrodnying

Lecture 25 - Practical Signals

Lecture 26 - Basics Of Instrumentation

Lecture 27 - Signal Conditioning And Filtering

Lecture 28 - Errors In Measurements

Lecture 29 - Dynamic Range And Frequency Response

Lecture 30 - Overview Of Transducers For Cbm

Lecture 31 - Accelerometers

- Lecture 32 - Vibration Monitoring
- Lecture 33 - Rotational Speed Measurements
- Lecture 34 - Basics of Noise
- Lecture 35 - Noise Monitoring
- Lecture 36 - Introduction to Faults in Rotating Machines
- Lecture 37 - Unbalance Detection
- Lecture 38 - Field Balancing
- Lecture 39 - Misalignment
- Lecture 40 - Crack and Looseness
- Lecture 41 - Journal and Anti-Friction Bearings
- Lecture 42 - Gears
- Lecture 43 - Pumps and Cavitation
- Lecture 44 - IC Engines
- Lecture 45 - Machinery Diagnostic Chart
- Lecture 46 - Principles of Motor Current Signature Analysis
- Lecture 47 - Faults in Electrical Machines
- Lecture 48 - Thermography
- Lecture 49 - Wear Debris Analysis
- Lecture 50 - Oil Analysis
- Lecture 51 - Ultrasonics
- Lecture 52 - Eddy Current and Acoustic Emission
- Lecture 53 - Radiography, Dye Penetrant Tests
- Lecture 54 - Tool Condition Monitoring
- Lecture 55 - Experimental Modal Analysis
- Lecture 56 - Introduction to Failure Analysis
- Lecture 57 - Railway Locomotive Noise and Vibration Monitoring
- Lecture 58 - Paper Mill Vibration Monitoring
- Lecture 59 - Overview of CBM facilities at IIT Kharagpur
- Lecture 60 - Future of Condition based Monitoring

Lecture 1 - Introduction

Lecture 2 - Geometry of single point turning tools - 1

Lecture 3 - Geometry of turning tools - 2

Lecture 4 - Geometry of single point turning tools - 3

Lecture 5 - Geometry of cutting tools and numerical problems

Lecture 6 - Different types of tools and mcq

Lecture 7 - Mechanism of chip formation

Lecture 8 - Mechanics of material removal

Lecture 9 - Measurement of Cutting Forces

Lecture 10 - Numerical problems and MCQ

Lecture 11 - Tool wear and Tool life

Lecture 12 - Wear and life of cutting tools - 2

Lecture 13 - The lathe

Lecture 14 - Calculations on mechanisms in machine tools

Lecture 15 - Numerical problems on lathe

Lecture 16 - Milling machines

Lecture 17 - Milling machine - indexing

Lecture 18 - Gear cutting CNC and non traditional machining

Lecture 19 - CNC and non-traditional machining methods

Lecture 20 - Numerical problems for week 4

Lecture 21 - Live Session

Lecture 1 - Introduction - Motivation and Theme of the Course

Lecture 2 - Laws of Gearing, Kinematics and Geometry - Part I

Lecture 3 - Laws of Gearing, Kinematics and Geometry - Part II

Lecture 4 - Involute Toothed Gear- Properties and Terminology

Lecture 5 - Tutorial

Lecture 6 - Involute Straight Tooth Spur Gear

Lecture 7 - Helical Tooth Spur Gear and Loads on Gear Shaft

Lecture 8 - Design of Bevel Gear

Lecture 9 - Crossed Helical Gear - I

Lecture 10 - Crossed Helical Gear - II and Worm Gear

Lecture 11 - Gear Unit Design - Selection of Stage Ratios, Pinion and Gear Teeth Numbers

Lecture 12 - Gear Unit Design - First Stage Pinion and Gear Design- I (Module on Beam Strength Basis)

Lecture 13 - Gear Unit Design - Failure of Gear Tooth (Probable Dynamic Load and Wear Load Capacity)

Lecture 14 - Gear Unit Design - 1st. Stage Pinion and Gear Design-II (Probable Dynamic Load and Wear Load Capacity and Finalizing 1st. Stage Pinion and Gear set)

Lecture 15 - Gear Unit Design - 1st. Layout (After Gear Design)

Lecture 16 - Bearing Arrangement - Gear Box Shafts

Lecture 17 - Bearing Load Calculation - Intermediate Shaft

Lecture 18 - Bearing Selection and Introduction to Shaft Design Verification

Lecture 19 - Design Verification of Gear Box Shafts

Lecture 20 - Development (Layout) of Intermediate Shaft

Lecture 21 - Development (Layout) of Input Shaft and Integral Pinion

Lecture 22 - Development (Layout) of Output Shaft and 2nd. Stage (Output) Gear

Lecture 23 - Development (Layout) of Output Shaft (Continued...), Loads on Shaft and Bearings

Lecture 24 - Output Shaft-Bearing Lives

Lecture 25 - Design Verification of Output Shaft

Lecture 26 - Design Verification of Input Shaft (including Bearing Life Estimation)

Lecture 27 - Finalizing Design including the Sizes of the Keys

Lecture 28 - Development of Plan and Elevation of Gear Reduction Unit - I

Lecture 29 - Development of Plan and Elevation of Gear Reduction Unit - II

Lecture 30 - Development of Plan and Elevation of Gear Reduction Unit - III

[Lecture 31](#)

[Lecture 32](#)

[Lecture 33 - Involute Spur Gear Tooth Correction : Part I](#)

[Lecture 34 - Involute Spur Gear Tooth Correction : Part II](#)

[Lecture 35 - Involute Spur Gear Tooth Correction : Part III](#)

[Lecture 36 - Involute Spur Gear Tooth Correction : Tutorial \(Workout Example\)](#)

[Lecture 37 - Involute Spur Gear Tooth Correction : Tutorial \(Workout Example-2\)](#)

[Lecture 38 - Tooth Tip Interference, Avoidance and Contact Ratio in Involute Internal Gearing](#)

[Lecture 39](#)

[Lecture 40](#)

[Lecture 41](#)

[Lecture 42](#)

[Lecture 43](#)

[Lecture 44](#)

[Lecture 45 - Live Session](#)



Lecture 1 - Principle of Optimization

Lecture 2 - Traditional Methods of Optimization

Lecture 3 - Traditional Methods of Optimization (Continued...)

Lecture 4 - Binary-Coded Genetic Algorithm (BCGA)

Lecture 5 - Binary-Coded Genetic Algorithm (BCGA) (Continued...)

Lecture 6 - Binary-Coded Genetic Algorithm (BCGA) (Continued...)

Lecture 7 - Binary-Coded Genetic Algorithm (BCGA) (Continued...)

Lecture 8 - Binary-Coded Genetic Algorithm (BCGA) (Continued...)

Lecture 9 - Schema Theorem of BCGA

Lecture 10 - Schema Theorem of BCGA (Continued...)

Lecture 11 - Constraint Handling

Lecture 12 - Real-Coded GA

Lecture 13 - Faster Genetic Algorithms

Lecture 14 - Faster Genetic Algorithms (Continued...)

Lecture 15 - Faster Genetic Algorithms (Continued...)

Lecture 16 - Faster Genetic Algorithms (Continued...)

Lecture 17 - Scheduling GA

Lecture 18 - Scheduling GA (Continued...)

Lecture 19 - Scheduling GA (Continued...)

Lecture 20 - Simulated Annealing

Lecture 21 - Particle Swarm Optimization

Lecture 22 - Multi-Objective Optimization

Lecture 23 - Multi-Objective Optimization (Continued...)

Lecture 24 - Multi-Objective Optimization (Continued...)

Lecture 25 - Multi-Objective Optimization (Continued...)

Lecture 26 - Multi-Objective Optimization (Continued...)

Lecture 27 - Intelligent Optimization Toolture

Lecture 28 - A Practical Optimization Problem

Lecture 29 - A Practical Optimization Problem (Continued...)

Lecture 30 - A Practical Optimization Problem (Continued...)

Lecture 31 - A Practical Optimization Problem (Continued...)

[Lecture 32 - A Practical Optimization Problem \(Continued...\)](#)

[Lecture 33 - A Practical Optimization Problem \(Continued...\)](#)

[Lecture 34 - A Practical Optimization Problem \(Continued...\)](#)

[Lecture 35 - A Practical Optimization Problem \(Continued...\)](#)

[Lecture 36 - A Practical Optimization Problem \(Continued...\)](#)

[Lecture 37 - Genetic Algorithm as Evolution Tool](#)

[Lecture 38 - Genetic Algorithm as Evolution Tool \(Continued...\)](#)

[Lecture 39 - Genetic Algorithm as Evolution Tool \(Continued...\)](#)

[Lecture 40 - Genetic Algorithm as Evolution Tool \(Continued...\)](#)

[Lecture 41 - Genetic Algorithm as Evolution Tool \(Continued...\)](#)

[Lecture 42 - Genetic Algorithm as Evolution Tool \(Continued...\)](#)

[Lecture 43 - Summary 1](#)

[Lecture 44 - Summary 2](#)

[Lecture 45 - Summary 3](#)

Lecture 1 - Introduction

Lecture 2 - Nomenclature

Lecture 3 - Kinematic Diagram

Lecture 4 - Degree of Freedom - I

Lecture 5 - Degree of Freedom - II

Lecture 6 - Degree of Freedom - Failure

Lecture 7 - Grashof Criteria - I

Lecture 8 - Grashof Criteria - II

Lecture 9 - Geometry and Representation of Vectors

Lecture 10 - Displacement Analysis: constrained mechanism - I

Lecture 11 - Displacement Analysis: constrained mechanism - II

Lecture 12 - Displacement Analysis: constrained mechanism - III

Lecture 13 - Displacement Analysis: constrained mechanism - IV

Lecture 14 - Displacement Analysis: open chain robot - I

Lecture 15 - Displacement Analysis: open chain robot - II

Lecture 16 - Displacement Analysis: open chain robot - III

Lecture 17 - Displacement Analysis: open chain robot - IV

Lecture 18 - Displacement Analysis: closed chain robot - I

Lecture 19 - Displacement Analysis: closed chain robot - II

Lecture 20 - Velocity Analysis: geometric concepts - I

Lecture 21 - Velocity Analysis: geometric concepts - II

Lecture 22 - Velocity Analysis: geometric concepts - III

Lecture 23 - Velocity Analysis: application of geometric concepts - I

Lecture 24 - Velocity Analysis: application of geometric concepts - II

Lecture 25 - Velocity Analysis: application of geometric concepts - III

Lecture 26 - Velocity Analysis: analytical approach - I

Lecture 27 - Velocity Analysis: analytical approach - II

Lecture 28 - Velocity Analysis: analytical approach - III

Lecture 29 - Serial Manipulator Velocity Analysis - I

Lecture 30 - Serial Manipulator Velocity Analysis - II

Lecture 31 - Serial Manipulator Velocity Analysis - III

[Lecture 32 - Parallel Manipulator Velocity Analysis](#)

[Lecture 33 - Path Generation Problem](#)

[Lecture 34 - Acceleration Analysis - I](#)

[Lecture 35 - Acceleration Analysis - II](#)

[Lecture 36 - Force Analysis - I](#)

[Lecture 37 - Force Analysis - II](#)

[Lecture 38 - Coordinate transformation - I](#)

[Lecture 39 - Coordinate transformation - II](#)

[Lecture 40 - Coordinate transformation - III](#)

Lecture 1 - Introduction

Lecture 2 - Applications of Heat Exchangers

Lecture 3 - Classification of Heat Exchangers

Lecture 4 - Classification of Heat Exchangers (Continued...)

Lecture 5 - Design and Simulation of Heat Exchangers

Lecture 6 - Design and Simulation

Lecture 7 - Design and Simulation of Heat Exchangers - Numerical Problem

Lecture 8 - Design and Simulation of Heat Exchangers - Numerical Problem (Continued...)

Lecture 9 - Design and Simulation of Heat Exchangers - Numerical Problem (Continued...)

Lecture 10 - Tubular Heat Exchanger Types

Lecture 11 - Tubular Heat Exchanger Types : Heat Transfer Co-efficient

Lecture 12 - Tubular Heat Exchanger : Double Pipe

Lecture 13 - Tubular Heat Exchanger : Shell - and - Tube

Lecture 14 - Tubular Heat Exchanger : Shell - and - Tube Design

Lecture 15 - Tubular Heat Exchanger : Shell - and - Tube Design (Continued...)

Lecture 16 - Enhancement of Heat Transfer compact Heat Exchangers

Lecture 17 - Extended Surface Heat Transfer

Lecture 18 - Extended Surface Heat Transfer: Some Example

Lecture 19 - Extended Surface Heat Exchangers: Some Example

Lecture 20 - Analysis of fin plates of finned tube heat exchanger

Lecture 21 - Finned tube heat exchanger

Lecture 22 - Finned tube heat exchanger (Continued...)

Lecture 23 - Finned tube heat exchanger (Continued...)

Lecture 24 - Plate fin heat exchanger

Lecture 25 - Plate fin heat exchanger (Continued...)

Lecture 26 - Plate fin heat exchanger (Continued...)

Lecture 27 - Plate fin heat exchanger : Analysis

Lecture 28 - Plate fin heat exchanger : Pressure drop

Lecture 29 - Plate fin heat exchanger : Numerical

Lecture 30 - Plate fin heat exchanger : Numerical (Continued...)

Lecture 31 - Plate fin heat exchanger : Numerical (Continued...)

- [Lecture 32 - Plate fin heat exchanger : Multistream](#)
- [Lecture 33 - Plate fin heat exchanger : Multistream \(Continued...\)](#)
- [Lecture 34 - Plate fin heat exchanger : Multistream Analysis](#)
- [Lecture 35 - Plate fin heat exchanger : Layer Stacking](#)
- [Lecture 36 - Phase change heat exchangers](#)
- [Lecture 37 - Phase change heat exchangers \(Continued...\)](#)
- [Lecture 38 - Surface Condenser](#)
- [Lecture 39 - Surface Condenser \(Continued...\)](#)
- [Lecture 40 - Surface Condenser \(Continued...\)](#)
- [Lecture 41 - Surface Condenser \(Continued...\)](#)
- [Lecture 42 - In tube condensation](#)
- [Lecture 43 - Heat pipes and Heat pipe heat exchangers](#)
- [Lecture 44 - Heat pipes and Heat pipe heat exchangers \(Continued...\)](#)
- [Lecture 45 - Heat pipes and Heat exchangers](#)
- [Lecture 46 - Heat pipes and Heat exchangers \(Continued...\)](#)
- [Lecture 47 - Micro Heat Exchanger Introduction](#)
- [Lecture 48 - Micro scale Heat Transfer](#)
- [Lecture 49 - Micro scale Heat Transfer \(Continued...\)](#)
- [Lecture 50 - Micro Channel](#)
- [Lecture 51 - Micro Heat Exchanger](#)
- [Lecture 52 - Regenerators](#)
- [Lecture 53 - Fixed Bed Regenerator Analysis](#)
- [Lecture 54 - Design and Simulation of Regenerator \(Fixed Bed\)](#)
- [Lecture 55 - Fixed Bed Regenerator \(Numerical\)](#)
- [Lecture 56 - Fixed Bed Regenerator \(Numerical\) \(Continued...\)](#)
- [Lecture 57 - Fouling in Heat Exchangers](#)
- [Lecture 58 - Fouling in Heat Exchangers \(Continued...\)](#)
- [Lecture 59 - Fouling in Heat Exchangers \(Continued...\)](#)
- [Lecture 60 - Direct Contact heat exchanger](#)
- [Lecture 61 - Direct Contact heat exchanger \(Continued...\)](#)
- [Lecture 62 - Heat exchanger network synthesis](#)
- [Lecture 63 - Heat exchanger network](#)
- [Lecture 64 - Heat exchanger network \(Continued...\)](#)

[Lecture 65 - Heat Exchanger Testing](#)

[Lecture 66 - Heat Exchanger Testing \(Continued...\)](#)

- Lecture 1 - Introduction to Robots and Robotics
- Lecture 2 - Introduction to Robots and Robotics (Continued...)
- Lecture 3 - Introduction to Robots and Robotics (Continued...)
- Lecture 4 - Introduction to Robots and Robotics (Continued...)
- Lecture 5 - Introduction to Robots and Robotics (Continued...)
- Lecture 6 - Introduction to Robots and Robotics (Continued...)
- Lecture 7 - Introduction to Robots and Robotics (Continued...)
- Lecture 8 - Introduction to Robots and Robotics (Continued...)
- Lecture 9 - Introduction to Robots and Robotics (Continued...)
- Lecture 10 - Introduction to Robots and Robotics (Continued...)
- Lecture 11 - Robot Kinematics
- Lecture 12 - Robot Kinematics (Continued...)
- Lecture 13 - Robot Kinematics (Continued...)
- Lecture 14 - Robot Kinematics (Continued...)
- Lecture 15 - Robot Kinematics (Continued...)
- Lecture 16 - Robot Kinematics (Continued...)
- Lecture 17 - Robot Kinematics (Continued...)
- Lecture 18 - Robot Kinematics (Continued...)
- Lecture 19 - Robot Kinematics (Continued...)
- Lecture 20 - Robot Kinematics (Continued...)
- Lecture 21 - Trajectory Planning
- Lecture 22 - Trajectory Planning (Continued...)
- Lecture 23 - Singularity Checking
- Lecture 24 - Robot Dynamics
- Lecture 25 - Robot Dynamics (Continued...)
- Lecture 26 - Robot Dynamics (Continued...)
- Lecture 27 - Robot Dynamics (Continued...)
- Lecture 28 - Robot Dynamics (Continued...)
- Lecture 29 - Robot Dynamics (Continued...)
- Lecture 30 - Control Scheme
- Lecture 31 - Sensors



[Lecture 32 - Sensors \(Continued...\)](#)

[Lecture 33 - Sensors \(Continued...\)](#)

[Lecture 34 - Robot Vision](#)

[Lecture 35 - Robot Vision \(Continued...\)](#)

[Lecture 36 - Robot Vision \(Continued...\)](#)

[Lecture 37 - Robot Motion Planning](#)

[Lecture 38 - Robot Motion Planning \(Continued...\)](#)

[Lecture 39 - Robot Motion Planning \(Continued...\)](#)

[Lecture 40 - Robot Motion Planning \(Continued...\)](#)

[Lecture 41 - Intelligent Robot](#)

[Lecture 42 - Biped Walking](#)

[Lecture 43 - Biped Walking \(Continued...\)](#)

[Lecture 44 - Summary](#)

[Lecture 45 - Summary \(Continued...\)](#)

Lecture 1 - Introduction to CFD

Lecture 2 - Classification of partial differential equations

Lecture 3 - Examples of partial differential equations

Lecture 4 - Examples of partial differential equations (Continued...)

Lecture 5 - Nature of the characteristics of partial differential equation

Lecture 6 - Euler-Lagrangian equation

Lecture 7 - Approximate Solutions of Differential Equations

Lecture 8 - Variational formulation

Lecture 9 - Example of variational formulation and introduction to weighted residual method

Lecture 10 - Weighted residual method (Continued...)

Lecture 11 - Point Collocation method, the Galerkin's method and the 'M' form

Lecture 12 - Finite element method (FEM) of discretization

Lecture 13 - Finite element method of discretization (Continued...)

Lecture 14 - Finite difference method (FDM) of discretization

Lecture 15 - Well posed boundary value problem

Lecture 16 - Finite volume method (FVM) of discretization

Lecture 17 - Illustrative examples of finite volume method

Lecture 18 - Illustrative examples of finite volume method (Continued...)

Lecture 19 - Basic rules of finite volume discretization

Lecture 20 - Implementation of boundary conditions in FVM

Lecture 21 - Implementation of boundary conditions in FVM (Continued...)

Lecture 22 - 1-D Unsteady state diffusion problem

Lecture 23 - 1-D Unsteady state diffusion problem (Continued...)

Lecture 24 - Consequences of Discretization of Unsteady State Problems

Lecture 25 - FTCS scheme

Lecture 26 - CTCS scheme (Leap frog scheme) and Dufort-Frankel scheme

Lecture 27 - Part 1: FV Discretization of 2-D Unsteady State Diffusion Type problems; Part 2: Solution to linear algebraic equations

Lecture 28 - Solution to linear algebraic equations (Continued...)

Lecture 29 - Elimination methods

Lecture 30 - Gaussian elimination and LU Decomposition methods

Lecture 31 - Illustrative example of elimination method

- Lecture 32 - Tri-Diagonal Matrix Algorithm (TDMA)
- Lecture 33 - Elimination Methods: Error Analysis
- Lecture 34 - Elimination Methods: Error Analysis (Continued...)
- Lecture 35 - Iteration methods
- Lecture 36 - Generalized analysis of Iteration method
- Lecture 37 - Further discussion on Iterative methods
- Lecture 38 - Illustrative examples of Iterative methods
- Lecture 39 - Gradient Search based methods
- Lecture 40 - Steepest descent method (Continued...)
- Lecture 41 - Conjugate gradient method
- Lecture 42 - Convection diffusion equation
- Lecture 43 - Central difference scheme applied to convection-diffusion equation
- Lecture 44 - Upwind scheme
- Lecture 45 - Illustrative examples
- Lecture 46 - Exact solution of 1-D steady state convection diffusion equation (Continued...)
- Lecture 47 - Exponential scheme
- Lecture 48 - Generalized convection diffusion formulation
- Lecture 49 - 2-D convection diffusion problem
- Lecture 50 - False (numerical) diffusion scheme and the QUICK scheme
- Lecture 51 - Discretization of Navier Stokes equation
- Lecture 52 - Discretization of Navier Stokes equation (Continued...)
- Lecture 53 - Concept of staggered grid
- Lecture 54 - SIMPLE algorithm
- Lecture 55 - Salient features of SIMPLE algorithm
- Lecture 56 - Illustrative examples on the use of SIMPLE algorithm
- Lecture 57 - SIMPLER algorithm
- Lecture 58 - Illustrative examples of SIMPLER algorithm
- Lecture 59 - What is there in implementing a CFD Code
- Lecture 60 - Some representative case studies

Lecture 1 - Introductory Concepts

Lecture 2 - Properties of Pure Substances

Lecture 3 - Properties of Pure Substances (Continued...)

Lecture 4 - Introduction to Property Tables

Lecture 5 - Properties of Pure Substances: Example problems (Continued...)

Lecture 6 - Properties of Pure Substances: Example problems (Continued...)

Lecture 7 - Use of Computer as Means of Learning Thermodynamics

Lecture 8 - Properties of Pure Substances (Continued...)

Lecture 9 - Properties of Pure Substances Spring - Piston Problem

Lecture 10 - Heat and Work

Lecture 11 - Heat and Work : Representative Problems

Lecture 12 - Heat and Work : Representative Problems (Continued...)

Lecture 13 - Heat and Work : Representative Problems (Continued...)

Lecture 14 - First Law of Thermodynamics for a Control Mass System

Lecture 15 - Enthalpy and Specific Heats

Lecture 16 - First Law for a Control Mass System : Representative Examples

Lecture 17 - First Law for a Control Mass System : Representative Examples (Continued...)

Lecture 18 - First Law for a Control Mass System : Representative Examples (Continued...)

Lecture 19 - Control Volume Conservation Reynolds Transport Theorem

Lecture 20 - Control Volume Mass and Energy Balance

Lecture 21 - Supplementary Lecture: Problem solving with the aid of a computer

Lecture 22 - First Law for Steady State Steady Flow (SSSF) Process

Lecture 23 - First Law for SSSF Process : Example Problem

Lecture 24 - First Law for SSSF Process : Example Problem (Continued...)

Lecture 25 - First Law for SSSF Process : Example Problem (Continued...)

Lecture 26 - First Law for SSSF Process : Example Problem (Continued...)

Lecture 27 - Supplementary Lecture: Problem solving with the aid of a computer

Lecture 28 - First Law of Thermodynamics for Unsteady Processes in a Control Volume

Lecture 29 - First Law for Unsteady Problems - Examples

Lecture 30 - First Law for Unsteady Problems - Examples (Continued...)

Lecture 31 - First Law for Unsteady Problems - Examples (Continued...)

- Lecture 32 - Supplementary Lecture : Problem Solving with the Aid of a Computer
- Lecture 33 - Introduction to Second Law of Thermodynamics
- Lecture 34 - Statements of the Second Law of Thermodynamics
- Lecture 35 - Perpetual Motion Machines; Reversible and Irreversible Processes
- Lecture 36 - Factors for Irreversibility and Introduction to Reversible Cycles
- Lecture 37 - Carnot Theorem and Absolute Temperature Scale
- Lecture 38 - Second Law: Illustrative Problems
- Lecture 39 - Clausius Inequality and Introduction to Entropy
- Lecture 40 - Thermodynamic Property Relationships; Entropy change for Solids, Liquids and Ideal gases
- Lecture 41 - Entropy balance for Reversible and Irreversible Processes
- Lecture 42 - What is Entropy ?
- Lecture 43 - Entropy Change in closed system: Examples
- Lecture 44 - Entropy Change in closed system: Examples
- Lecture 45 - Supplementary Lecture: Problem solving with the aid of a computer
- Lecture 46 - Supplementary Lecture: Problem solving with the aid of a computer
- Lecture 47 - Entropy Transport for a flow process
- Lecture 48 - Entropy Transport for flow process: Examples
- Lecture 49 - Entropy Transport for flow process: Examples
- Lecture 50 - Entropy Transport for flow process: Examples
- Lecture 51 - Entropy Transport for flow process: Examples
- Lecture 52 - Supplementary Lecture: Problem solving with the aid of a computer
- Lecture 53 - Exergy (Availability)
- Lecture 54 - Exergy (Availability) (Continued...)
- Lecture 55 - Exergy Analysis : Examples
- Lecture 56 - Exergy Analysis : Examples (Continued...)
- Lecture 57 - Thermodynamic Relationships
- Lecture 58 - Thermodynamic Relationships (Continued...)
- Lecture 59 - Otto Cycle
- Lecture 60 - Diesel Cycle
- Lecture 61 - Example Problems : Otto Cycle and Diesel Cycle
- Lecture 62 - Brayton Cycle
- Lecture 63 - Carnot Cycle and Rankine Cycle
- Lecture 64 - Carnot Cycle and Rankine Cycle (Continued...)

[Lecture 65 - Vapour Compression Refrigeration Cycle](#)

[Lecture 66 - Review of Learning Concepts](#)

[Lecture 67 - Supplementary Lecture: Problem solving with the aid of a computer](#)

[Lecture 68 - Supplementary Lecture: Problem solving with the aid of a computer](#)

Lecture 1 - Introduction - 1

Lecture 2 - Introduction - 2

Lecture 3 - Introduction - 3

Lecture 4 - Semiconductors and Components - 1

Lecture 5 - Semiconductors and Components - 2

Lecture 6 - 1st Level Packaging - I

Lecture 7 - 1st Level Packaging - II

Lecture 8 - Area Array Packages - I

Lecture 9 - Area Array Packages - II

Lecture 10 - Area Array Packages - III

Lecture 11 - Flip Chip Technology

Lecture 12 - 1st Level Interconnections - I

Lecture 13 - 1st Level Interconnections - II

Lecture 14 - 1st Level Interconnections - III

Lecture 15 - Advanced Packaging

Lecture 16 - 2nd Level Packaging: PCB - I

Lecture 17 - 2nd Level Packaging: PCB - II

Lecture 18 - 2nd Level Packaging: PCB - III

Lecture 19 - 2nd Level Packaging: PCB - IV

Lecture 20 - 2nd Level Packaging: PCB - V

Lecture 21 - System Integration

Lecture 22 - Thermal Management 1: Introduction

Lecture 23 - Thermal Management 2: Concepts

Lecture 24 - Thermal Management 3: Thermal Resistance

Lecture 25 - Thermal Management 4: Heat Sink

Lecture 26 - Thermal Management 5: Heat Sink Characterization

Lecture 27 - Thermal Management 6: Heat Transfer Correlations

Lecture 28 - Thermal Management 7: Practice Problems

Lecture 29 - Thermal Management 8: Thermal Technologies

Lecture 30 - Thermal Management 9: Novel Cooling Technologies

Lecture 31 - Shock and Vibration - 1

[Lecture 32 - Shock and Vibration - 2](#)

[Lecture 33 - Shock and Vibration - 3](#)

[Lecture 34 - Shock and Vibration - 4](#)

[Lecture 35 - Electronic Packaging Reliability - 1](#)

[Lecture 36 - Electronic Packaging Reliability - 2](#)

[Lecture 37 - Electronic Packaging Reliability - 3](#)

[Lecture 38 - Electronic Packaging Reliability - 4](#)

[Lecture 39 - Power Electronics Packaging](#)

[Lecture 40 - Special Topics](#)



Lecture 1 - Introduction and Motivation

Lecture 2 - Nomenclature and Classification

Lecture 3 - Kinematic Diagram

Lecture 4 - Degree of Freedom

Lecture 5 - Constrained and Robotic Mechanisms

Lecture 6 - Failure of DOF Calculation

Lecture 7 - Grashof Criterion - I

Lecture 8 - Grashof Criterion - II

Lecture 9 - Grashof Criterion - Problems

Lecture 10 - Displacement Analysis - I

Lecture 11 - Displacement Analysis - II

Lecture 12 - Displacement Analysis Example - I

Lecture 13 - Displacement Analysis Example - II

Lecture 14 - Steering Mechanisms

Lecture 15 - Displacement Analysis of Robots - I

Lecture 16 - Displacement Analysis of Robots - II

Lecture 17 - Displacement Analysis of Robots - III

Lecture 18 - Geometric Velocity Analysis - I

Lecture 19 - Geometric Velocity Analysis - II

Lecture 20 - Geometric Velocity Analysis - III

Lecture 21 - Velocity Analysis: Method of IC - I

Lecture 22 - Velocity Analysis: Method of IC - II

Lecture 23 - Velocity Analysis: Method of IC - III

Lecture 24 - Analytical Velocity Analysis - I

Lecture 25 - Analytical Velocity Analysis - II

Lecture 26 - Analytical Velocity Analysis - III

Lecture 27 - Velocity Analysis Examples

Lecture 28 - Robot Velocity Analysis - I

Lecture 29 - Robot Velocity Analysis - II

Lecture 30 - Robot Velocity Analysis - III

Lecture 31 - Robot Path Generation

[Lecture 32 - Acceleration Analysis - I](#)

[Lecture 33 - Acceleration Analysis - II](#)

[Lecture 34 - Force Analysis - I](#)

[Lecture 35 - Force Analysis - II](#)

[Lecture 36 - Force Analysis Examples](#)

[Lecture 37 - Gear Kinematics](#)

[Lecture 38 - Gear trains - I](#)

[Lecture 39 - Gear trains - II](#)

[Lecture 40 - Gear trains - III](#)

Lecture 1 - Motivations of studying fluid mechanics

Lecture 2 - Macroscopic and microscopic point of views

Lecture 3 - Concept of traction vector

Lecture 4 - Cauchy's theorem

Lecture 5 - Concept of pressure in a fluid

Lecture 6 - Density, Bulk Modulus, Viscosity

Lecture 7 - Viscosity, Newtonian fluid

Lecture 8 - Kinematic viscosity, Reynolds number

Lecture 9 - Non-Newtonian fluids

Lecture 10 - Some illustrative examples solved

Lecture 11 - Problems and Solutions

Lecture 12 - Surface Tension - Part I

Lecture 13 - Surface Tension - Part II

Lecture 14 - Governing equation of fluid statics

Lecture 15 - Manometers

Lecture 16 - Force on a surface immersed in fluid - Part I

Lecture 17 - Force on a surface immersed in fluid - Part II

Lecture 18 - Force on a surface immersed in fluid - Part III, Stability of solid bodies in fluid - Part I

Lecture 19 - Stability of solid bodies in fluid - Part II

Lecture 20 - Fluid under rigid body motion

Lecture 21 - Lagrangian and Eulerian approaches

Lecture 22 - Concept of different flow lines

Lecture 23 - Acceleration of fluid flow

Lecture 24 - Deformation of fluid elements - Part I

Lecture 25 - Derivation of continuity equation

Lecture 26 - Problems and Solutions

Lecture 27 - Deformation of fluid elements - Part II

Lecture 28 - Deformation of fluid elements - Part III

Lecture 29 - Stream Function

Lecture 30 - Circulation, Velocity Potential

Lecture 31 - Euler's equation

- Lecture 32 - Bernoulli's equation - Part I
- Lecture 33 - Bernoulli's equation - Part II
- Lecture 34 - Bernoulli's equation - Part III
- Lecture 35 - Euler's equation in streamline coordinates
- Lecture 36 - Problems and Solutions
- Lecture 37 - Problems and Solutions
- Lecture 38 - Application of Bernoulli's equation - Part I
- Lecture 39 - Application of Bernoulli's equation - Part II
- Lecture 40 - Application of Bernoulli's equation - Part III
- Lecture 41 - Reynolds Transport Theorem (RTT)
- Lecture 42 - Application of RTT: Conservation of mass
- Lecture 43 - Problems and Solutions
- Lecture 44 - Problems and Solutions
- Lecture 45 - Application of RTT: Conservation of linear momentum
- Lecture 46 - Problems and Solutions
- Lecture 47 - Problems and Solutions
- Lecture 48 - Problems and Solutions
- Lecture 49 - Application of RTT: Conservation of angular momentum
- Lecture 50 - Problems and Solutions
- Lecture 51 - Navier-Stokes equation - Part I
- Lecture 52 - Navier-Stokes equation - Part II
- Lecture 53 - Navier-Stokes equation - Part III
- Lecture 54 - Navier-Stokes equation - Part IV
- Lecture 55 - Pipe Flow - Part I
- Lecture 56 - Pipe Flow - Part II
- Lecture 57 - Pipe Flow - Part III
- Lecture 58 - Pipe Flow - Part IV
- Lecture 59 - Principle of Similarity and Dynamical Analysis - Part I
- Lecture 60 - Principle of Similarity and Dynamical Analysis - Part II

Lecture 1 - Introduction To Conduction

Lecture 2 - 1-D Steady State Conduction

Lecture 3 - Introduction To Convection

Lecture 4 - Conduction Equation:Internal Energy Form

Lecture 5 - Conduction Equation:C-P Form

Lecture 6 - Conduction Equation:Boundary Conditions And Problems

Lecture 7 - 1-D Steady State Conduction

Lecture 8 - Concept Of Thermal Resistance

Lecture 9 - 1-D Steady State Conduction - II

Lecture 10 - 1-D Steady State Conduction - II (Continued...)

Lecture 11 - Problems On 1-D Steady State Conduction - I

Lecture 12 - Problems On 1-D Steady State Conduction - I (Continued....)

Lecture 13 - Problems On 1-D Steady State Conduction - II

Lecture 14 - Conduction In Cylindrical Geometry

Lecture 15 - Critical Insulation Thickness

Lecture 16 - Critical Insulation Thickness (Continued...)

Lecture 17 - Problems On Conduction In Cylindrical Geometry - I

Lecture 18 - Problems On Conduction In Cylindrical Geometry - I (Continued...)

Lecture 19 - Problems On Conduction In Cylindrical Geometry - II and Conduction in Spherical Geometry

Lecture 20 - Heat Transfer From Extended surfaces

Lecture 21 - Boundary Conditions at the FIN tip

Lecture 22 - Boundary Conditions at the FIN tip

Lecture 23 - Problems on Heat Transfer from Extended Surfaces

Lecture 24 - 2D Steady State Conduction

Lecture 25 - Separation of Variables Method for 2-D Steady State Conduction

Lecture 26 - Superposition Method for 2-D Steady State Conduction

Lecture 27 - Transient Conduction: Lumped Parameter Approach

Lecture 28 - Problems on Lumped Parameter Approach

Lecture 29 - Transient Conduction: Infinite Slab

Lecture 30 - Transient Conduction: Semi - Infinite Slab - I

Lecture 31 - Transient Conduction: Semi - Infinite Slab - II

[Lecture 32 - Introduction to Convection](#)

[Lecture 33 - Review of Fluid Mechanics - I](#)

[Lecture 34 - Review of Fluid Mechanics - II](#)

[Lecture 35 - Review of Fluid Mechanics - III](#)

[Lecture 36 - Review of Fluid Mechanics - IV](#)

[Lecture 37 - Review of Fluid Mechanics - V](#)

[Lecture 38 - Energy Conservation Equation - I](#)

[Lecture 39 - Energy Conservation Equation - II](#)

[Lecture 40 - Energy Conservation Equation - III](#)

[Lecture 41 - Thermal Boundary Layer - I](#)

[Lecture 42 - Thermal Boundary Layer - II](#)

[Lecture 43 - Energy Integral Equation - I](#)

[Lecture 44 - Energy Integral Equation - II](#)

[Lecture 45 - Internal Forced Convection - 1](#)

[Lecture 46 - Internal Forced Convection - 2](#)

[Lecture 47 - Internal Forced Convection - 3](#)

[Lecture 48 - Internal Forced Convection - 4](#)

[Lecture 49 - Internal Forced Convection - 5](#)

[Lecture 50 - Internal Forced Convection - 6](#)

[Lecture 51 - Viscous Dissipation - 1](#)

[Lecture 52 - Viscous Dissipation - 2](#)

[Lecture 53 - Natural Convection - 1](#)

[Lecture 54 - Natural Convection - 2](#)

[Lecture 55 - Natural Convection - 3](#)

[Lecture 56 - Natural Convection - 4](#)

[Lecture 57 - Condensation - I](#)

[Lecture 58 - Condensation - II](#)

[Lecture 59 - Boiling](#)

[Lecture 60 - Heat Exchangers - I](#)

[Lecture 61 - Heat Exchangers - II](#)

[Lecture 62 - Heat Exchangers - III](#)

[Lecture 63 - Heat Exchangers - IV](#)

[Lecture 64 - Heat Exchangers - V](#)



- Lecture 1 - Eulerian and Lagrangian Description of Fluid Motion
- Lecture 2 - Lines of Flow Visualization and Acceleration of Flow
- Lecture 3 - Angular Deformation of Fluid Elements
- Lecture 4 - Linear and Volumetric Deformation; Perspectives from Mass Conservation
- Lecture 5 - Continuity Equation in Integral Form : Stream Function and Velocity Potential
- Lecture 6 - Euler Equation for Inviscid Flow
- Lecture 7 - Bernoulli's Equation
- Lecture 8 - Examples of Bernoulli's Equation
- Lecture 9 - Reynolds Transport Equation
- Lecture 10 - Reynolds Transport Theorem : Mass and Linear Momentum Conservation
- Lecture 11 - Reynolds transport theorem : arbitrarily moving control volume
- Lecture 12 - Reynolds transport theorem : angular momentum conservation
- Lecture 13 - Introduction to traction vector and stress tensor
- Lecture 14 - Cauchy/Navier equation
- Lecture 15 - Navier Stokes equation
- Lecture 16 - Navier Stokes equation (Continued...)
- Lecture 17 - Some exact solutions of the Navier Stokes equation
- Lecture 18 - Interfacial boundary conditions and example of thin film flows
- Lecture 19 - Exact solutions of the Navier Stokes equations in cylindrical polar coordinates
- Lecture 20 - Exact solutions of the Navier Stokes equation for some unsteady flows
- Lecture 21 - Confined oscillatory flows
- Lecture 22 - Introduction to Turbulence
- Lecture 23 - Statistical Treatment of Turbulence and Near - Wall Velocity Profiles
- Lecture 24 - Introduction to Boundary Layer Theory
- Lecture 25 - Similarity Solution of Boundary Layer Equation
- Lecture 26 - Momentum Integral Method
- Lecture 27 - Application of Momentum Integral Method and Boundary Layer Separation
- Lecture 28 - Potential Flow
- Lecture 29 - Potential Flow (Continued...)
- Lecture 30 - Potential Flow (Continued...)
- Lecture 31 - Potential Flow (Continued...)



- [Lecture 32 - Potential Flow \(Continued...\)](#)
- [Lecture 33 - Potential Flow \(Continued...\)](#)
- [Lecture 34 - Stokes Flow past a Sphere](#)
- [Lecture 35 - Stokes Flow past a Sphere \(Continued...\)](#)
- [Lecture 36 - Stokes Flow past a Sphere \(Continued...\)](#)
- [Lecture 37 - Lubrication Theory](#)
- [Lecture 38 - Lubrication Theory \(Continued...\)](#)
- [Lecture 39 - Lubrication Theory \(Continued...\)](#)
- [Lecture 40 - Thin Film Dynamics](#)
- [Lecture 41 - Thin Film Dynamics \(Continued...\)](#)
- [Lecture 42 - Thin Film Dynamics \(Continued...\)](#)
- [Lecture 43 - Thin Film Dynamics \(Continued...\)](#)
- [Lecture 44 - Thin Film Dynamics \(Continued...\)](#)
- [Lecture 45 - Thin Film Dynamics \(Continued...\)](#)
- [Lecture 46 - Thin Film Dynamics \(Continued...\)](#)
- [Lecture 47 - Thin Film Dynamics \(Continued...\)](#)
- [Lecture 48 - Compressible Flows](#)
- [Lecture 49 - Compressible Flows \(Continued...\)](#)
- [Lecture 50 - Compressible Flows \(Stagnation Properties\)](#)
- [Lecture 51 - Compressible Flows \(Stagnation Properties, Variable Area\)](#)
- [Lecture 52 - Compressible Flows \(Variable Area\)](#)
- [Lecture 53 - Compressible Flows \(Variable Area\)](#)
- [Lecture 54 - Compressible Flows \(Normal Shock\)](#)
- [Lecture 55 - Compressible Flows \(Normal Shock\) \(Continued...\)](#)
- [Lecture 56 - Compressible Flows \(Converging Nozzle\)](#)
- [Lecture 57 - Compressible Flows \(Converging Diverging Nozzle\)](#)
- [Lecture 58 - Compressible Flows \(Converging Diverging Nozzle\) \(Continued...\)](#)
- [Lecture 59 - Compressible Flows with Friction](#)

- Lecture 1 - Introduction to High Performance Computing
- Lecture 2 - Architecture for Parallel Computing
- Lecture 3 - Architecture for Parallel Computing (Continued...)
- Lecture 4 - Architecture for Parallel Computing (Continued...)
- Lecture 5 - Shared Memory and Distributed Memory in Parallel Computing
- Lecture 6 - Shared Memory and Distributed Memory in Parallel Computing (Continued...)
- Lecture 7 - Parallel Algorithms
- Lecture 8 - Parallel Algorithms (Continued...)
- Lecture 9 - Parallel Algorithms (Continued...)
- Lecture 10 - Performance Metrics of Parallel Systems
- Lecture 11 - Performance Metrics of Parallel Systems (Continued...)
- Lecture 12 - Introduction to OpenMP
- Lecture 13 - Introduction to OpenMP (Continued...)
- Lecture 14 - Introduction to OpenMP (Continued...)
- Lecture 15 - Essentials of OpenMP Programming
- Lecture 16 - Essentials of OpenMP Programming (Continued...)
- Lecture 17 - Data sharing and synchronization
- Lecture 18 - Efficient OpenMP programming for matrix computing
- Lecture 19 - Introduction to MPI and Distributed Memory Parallel Programming
- Lecture 20 - Introduction to MPI and Distributed Memory Parallel Programming (Continued...)
- Lecture 21 - Communication using MPI
- Lecture 22 - Communication using MPI (Continued...)
- Lecture 23 - Communication using MPI (Continued...)
- Lecture 24 - Matrix Representation of Physical Systems - Matrix Solvers
- Lecture 25 - Domain Decomposition Technique
- Lecture 26 - Domain decomposition based parallelization of matrix solvers
- Lecture 27 - Domain decomposition based parallelization of matrix solvers (Continued...)
- Lecture 28 - Domain decomposition based parallelization of matrix solvers (Continued...)
- Lecture 29 - MPI routines for parallel matrix solvers
- Lecture 30 - Introduction to GPGPU and CUDA
- Lecture 31 - Introduction to GPGPU and CUDA (Continued...)

[Lecture 32 - Introduction to GPGPU and CUDA \(Continued...\)](#)

[Lecture 33 - Introduction to GPGPU and CUDA \(Continued...\)](#)

[Lecture 34 - Introduction to CUDA programming](#)

[Lecture 35 - Introduction to CUDA programming \(Continued...\)](#)

[Lecture 36 - Thread execution in CUDA program - scheduling and memory access](#)

[Lecture 37 - Thread execution in CUDA program \(Continued...\)](#)

[Lecture 38 - Matrix multiplications in CUDA](#)

[Lecture 39 - OpenACC programming for GPU-s](#)

[Lecture 40 - Hybrid parallelization and exascale computing](#)

[Lecture 1 - Introduction - I](#)

[Lecture 2 - Introduction - II](#)

[Lecture 3 - Introduction - III](#)

[Lecture 4 - Introduction - IV](#)

[Lecture 5 - Introduction - V](#)

[Lecture 6 - Introduction - VI](#)

[Lecture 7 - Conic Sections - I](#)

[Lecture 8 - Conic Sections - II](#)

[Lecture 9 - Practice - I](#)

[Lecture 10 - Practice - II](#)

[Lecture 11 - Conic Sections - III](#)

[Lecture 12 - Conic Sections - IV](#)

[Lecture 13 - Conic Sections - V](#)

[Lecture 14 - Conic Sections - VI](#)

[Lecture 15 - Conic Sections - VII](#)

[Lecture 16 - Conic Sections - VIII](#)

[Lecture 17 - Conic Sections - IX](#)

[Lecture 18 - Conic Sections - X](#)

[Lecture 19 - Conic Sections - XI](#)

[Lecture 20 - Conic Sections - XII](#)

[Lecture 21 - Orthographic Projections I - Part 1](#)

[Lecture 22 - Orthographic Projections I - Part 2](#)

[Lecture 23 - Orthographic Projections I - Part 3](#)

[Lecture 24 - Orthographic Projections I - Part 4](#)

[Lecture 25 - Orthographic Projections I - Part 5](#)

[Lecture 26 - Orthographic Projections I - Part 6](#)

[Lecture 27 - Orthographic Projections I - Part 7](#)

[Lecture 28 - Orthographic Projections I - Part 8](#)

[Lecture 29 - Orthographic Projections I - Part 9](#)

[Lecture 30 - Orthographic Projections I - Part 10](#)

[Lecture 31 - Orthographic Projections II - Part 1](#)

[Lecture 32 - Orthographic Projections II - Part 2](#)

[Lecture 33 - Orthographic Projections II - Part 3](#)

[Lecture 34 - Orthographic Projections II - Part 4](#)

[Lecture 35 - Orthographic Projections II - Part 5](#)

[Lecture 36 - Orthographic Projections II - Part 6](#)

[Lecture 37 - Orthographic Projections II - Part 7](#)

[Lecture 38 - Orthographic Projections II - Part 8](#)

[Lecture 39 - Orthographic Projections II - Part 9](#)

[Lecture 40 - Orthographic Projections II - Part 10](#)

[Lecture 41 - Orthographic Projections II - Part 11](#)

[Lecture 42 - Projection of Solids - I](#)

[Lecture 43 - Projection of Solids - II](#)

[Lecture 44 - Projection of Solids - III](#)

[Lecture 45 - Sections and Sectional Views](#)

[Lecture 46 - Sections and Sectional Views \(Continued...\)](#)

[Lecture 47 - Sections and Sectional Views \(Continued...\)](#)

[Lecture 48 - Isometric Projections](#)

[Lecture 49 - Isometric Projections \(Continued...\)](#)

[Lecture 50 - Isometric Projections \(Continued...\)](#)

[Lecture 51 - Overview of Computer Graphics - I](#)

[Lecture 52 - Overview of Computer Graphics - II](#)

[Lecture 53 - Overview of Computer Graphics - III](#)

[Lecture 54 - Overview of Computer Graphics - IV](#)

[Lecture 55 - Solidworks](#)

[Lecture 56 - Solidworks \(Continued...\)](#)

[Lecture 57 - Solidworks \(Continued...\)](#)

[Lecture 58 - Solidworks \(Continued...\)](#)

[Lecture 59 - Solidworks \(Continued...\)](#)

[Lecture 60 - Solidworks \(Continued...\)](#)

[Lecture 61 - Assembly Drawing](#)

[Lecture 62 - Assembly Drawing \(Continued...\)](#)

[Lecture 63 - Assembly Drawing \(Continued...\)](#)

[Lecture 64 - Assembly Drawing \(Continued...\)](#)

[Lecture 65 - Assembly Drawing \(Continued...\)](#)

Lecture 1 - Preliminaries and Data types

Lecture 2 - Loops and Conditionals Implementation of bubble sort

Lecture 3 - Commonly used Functions

Lecture 4 - Matrix Manipulations Mohr's circle

Lecture 5 - Nonlinear algebraic equations - Visualizing convergence

Lecture 6 - Nonlinear algebraic equations - system of equation and Newton's basin of attraction

Lecture 7 - Overview of Jupyterlab, Octave GUI, Spyder GUI

Lecture 8 - Interactivity with Python - Ipywidgets

Lecture 9 - Geometric Interpretations of ODEs

Lecture 10 - Bifurcation: Saddle node bifurcation

Lecture 11 - Bifurcation: Transcritical bifurcation

Lecture 12 - Bifurcation: Pitchfork bifurcation

Lecture 13 - Imperfect bifurcations and catastrophies

Lecture 14 - 2D flows - linear systems

Lecture 15 - 2D flows - Trajectories: spirals, star and degeneracy

Lecture 16 - Phase portraits - nonlinear systems

Lecture 17 - 2D phase portraits - limit cycles

Lecture 18 - Bifurcations and 3D flows

Lecture 19 - 1D Maps

Lecture 20 - Probability density functions and sampling

Lecture 21 - Monte-carlo simulations: Darts and Buffon's needle

Lecture 22 - 1D Random walks

Lecture 23 - 2D Random walks

Lecture 24 - Boundary Value Problems - Part 1

Lecture 25 - Boundary Value Problems - Part 2

Lecture 26 - Regular Perturbation for ODE

Lecture 27 - Singular Perturbation for ODE

Lecture 28 - 2D Boundary Values Problems

Lecture 29 - PETSc and MPI basics

Lecture 30 - PETSc - Creating Vectors and Matrices

Lecture 31 - KSP object and solving a system

[Lecture 32 - Poisson equation in PETSc](#)

[Lecture 33 - Nonlinear Solver of PETSc](#)

[Lecture 34 - Nonlinear solver with Jacobian in PETSc](#)

[Lecture 35 - Reaction-diffusion system in PETSc](#)

[Lecture 36 - Time stepping in PETSc](#)

[Lecture 37 - Heat transport using PETSc](#)

[Lecture 38 - Solving nonlinear PDE on a periodic domain yielding different patterns](#)

[Lecture 39 - Audio analysis - Determine motor RPM](#)

[Lecture 40 - Spectrogram and Doppler shift](#)

[Lecture 41 - Image processing - Preliminaries](#)

[Lecture 42 - Balloon problem and viscous fingers](#)

[Lecture 43 - Analyzing data files and 2D interpolation](#)



Lecture 1 - Coordinate Systems - I

Lecture 2 - Coordinate Systems - II

Lecture 3 - Relative Motion - I

Lecture 4 - Relative Motion - II

Lecture 5 - Relative Motion - III

Lecture 6 - Particle kinetics - I

Lecture 7 - Particle kinetics - II

Lecture 8 - Particle kinetics - III

Lecture 9 - Particle kinetics - IV

Lecture 10 - Particle kinetics - V

Lecture 11 - Work-energy relation - I

Lecture 12 - Work-energy relation - II

Lecture 13 - Impulse-momentum relation - I

Lecture 14 - Impulse-momentum relation - II

Lecture 15 - Particle impact - I

Lecture 16 - Particle impact - II

Lecture 17 - Central force motion - I

Lecture 18 - Central force motion - II

Lecture 19 - Central force motion - III

Lecture 20 - Central force motion - IV

Lecture 21 - Systems with Mass Flow - I

Lecture 22 - Systems with Mass Flow - II

Lecture 23 - Kinetics of a System of Particles - I

Lecture 24 - Kinetics of a System of Particles - II

Lecture 25 - Kinetics of a System of Particles - III

Lecture 26 - Kinetics of a System of Particles: Extension to Rigid Bodies

Lecture 27 - Planar Kinetics of Rigid Bodies - I

Lecture 28 - Planar Kinetics of Rigid Bodies - II

Lecture 29 - Planar Kinetics: Work-Energy Relations - I

Lecture 30 - Planar Kinetics: Work-Energy Relations - II

Lecture 31 - Planar kinetics: impulse-momentum relations - I

- Lecture 32 - Planar kinetics: impulse-momentum relations - II
- Lecture 33 - Spatial kinematics of rigid bodies - I
- Lecture 34 - Spatial kinematics of rigid bodies - II
- Lecture 35 - Spatial kinetics of rigid bodies - I
- Lecture 36 - Spatial kinetics of rigid bodies - II
- Lecture 37 - Spatial kinetics of rigid bodies - III
- Lecture 38 - Gyroscopic motion - I
- Lecture 39 - Gyroscopic motion - II
- Lecture 40 - Gyroscopic motion - III
- Lecture 41 - Kinematics of rotation - I
- Lecture 42 - Kinematics of rotation - II
- Lecture 43 - Kinematics of rotation - III
- Lecture 44 - Kinematics of rotation - IV
- Lecture 45 - Kinematics of rotation - V
- Lecture 46 - Introduction to Analytical Dynamics: generalized coordinates - I
- Lecture 47 - Introduction to Analytical Dynamics: generalized coordinates - II
- Lecture 48 - Hamilton's principle and Lagrange's equation of motion - I
- Lecture 49 - Hamilton's principle and Lagrange's equation of motion - II
- Lecture 50 - Hamilton's principle and Lagrange's equation of motion - III
- Lecture 51 - Hamilton's principle and Lagrange's equation of motion - IV
- Lecture 52 - Systems with constraints - I
- Lecture 53 - Systems with constraints - II
- Lecture 54 - Systems with constraints - III
- Lecture 55 - Systems with constraints - IV
- Lecture 56 - Symmetries and conservation laws - I
- Lecture 57 - Symmetries and conservation laws - II
- Lecture 58 - Symmetries and conservation laws - III
- Lecture 59 - Symmetries and conservation laws - IV
- Lecture 60 - Intermediate axis theorem

Lecture 1 - General Introduction to the Course

Lecture 2 - Musculoskeletal System

Lecture 3 - Synovial Joints

Lecture 4 - The Hip Joint

Lecture 5 - The Knee Joint

Lecture 6 - The Shoulder and Elbow Joints

Lecture 7 - The Spine

Lecture 8 - Biomechanics of the Hip Joint

Lecture 9 - Biomechanics of the Knee Joint

Lecture 10 - Biomechanics of the Shoulder Joint

Lecture 11 - Biomechanics of the Elbow Joint - Part I

Lecture 12 - Biomechanics of the Elbow Joint - Part II

Lecture 13 - Biomechanics of the Spine

Lecture 14 - Gait Cycle

Lecture 15 - Gait Analysis and Abnormalities

Lecture 16 - Measurement Techniques of Gait Analysis - Part I

Lecture 17 - Measurement Techniques of Gait Analysis - Part II

Lecture 18 - Motion Capture System

Lecture 19 - Fundamentals of Joint Kinematics

Lecture 20 - Joint Kinematics and Kinetics

Lecture 21 - Introduction to Musculoskeletal Modelling

Lecture 22 - Inverse Dynamics in Musculoskeletal Modelling

Lecture 23 - Muscle Force Estimation Using Static Optimization

Lecture 24 - Concepts of Stress and Strain

Lecture 25 - Stress Transformation

Lecture 26 - Bone Structure and Mechanical Behaviour

Lecture 27 - Bone Adaptation and Viscoelastic Behaviour

Lecture 28 - Anisotropic Nature of Bone

Lecture 29 - Implant Classification and Failure Mechanisms

Lecture 30 - Introduction to Finite Element Modelling of Bone and Implant

Lecture 31 - Finite Element Modelling and Analysis of Hip and Shoulder

[Lecture 32 - Modelling and Analysis of Intact and Implanted Lumbar Spine](#)

[Lecture 33 - Experimental Validation of Pre-Clinical Analysis](#)

[Lecture 34 - Adaptive Bone Remodelling](#)

[Lecture 35 - Bone Remodelling Around Resurfaced Femur and Pelvic Bone](#)

[Lecture 36 - Design Optimization of HIP Implant](#)

[Lecture 37 - Orthotropic Bone Remodelling](#)

[Lecture 38 - Biomaterials and Design of Orthopaedic Implants](#)

[Lecture 39 - Bone Fracture Healing](#)

[Lecture 40 - Bone Ingrowth and Mechanoregulatory Principles](#)

[Lecture 41 - Mathematical Modelling of Tissue Differentiation](#)

[Lecture 42 - Bone Ingrowth around Porous Coated Femoral Implant](#)

[Lecture 43 - Tissue Differentiation around Porous Coated Acetabular Implant](#)

[Lecture 44 - Concluding Remarks](#)

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

**NPTEL : NOC:Elements of Metal Cutting, Machine tools, Gear Cutting and CNC Machining (Mechanical Engineering)**

**Co-ordinators : Prof. Asimava Roy Choudhury**

Lecture 1 - Introduction

Lecture 2 - Geometry of single point turning tools - 1

Lecture 3 - Geometry of turning tools - 2

Lecture 4 - Geometry of single point turning tools -3

Lecture 5 - Geometry of cutting tools and numerical problems

Lecture 6 - Different types of tools and mcq

Lecture 7 - Mechanism of chip formation

Lecture 8 - Mechanics of material removal

Lecture 9 - Measurement Of Cutting Forces

Lecture 10 - Numerical problems and MCQ

Lecture 11 - Tool wear and Tool life

Lecture 12 - Wear and life of cutting tools - 2

Lecture 13 - The lathe

Lecture 14 - Calculations on mechanisms in machine tools

Lecture 15 - Numerical problems on lathe

Lecture 16 - milling machines

Lecture 17 - Milling machine - indexing

Lecture 18 - Gear cutting CNC and non traditional machining

Lecture 19 - CNC and non-traditional machining methods

Lecture 20 - Numerical problems for week 4

Lecture 21 - Introduction

Lecture 22 - Simple Gear Calculations

Lecture 23 - Gear Geometry

Lecture 24 - Helical Gear Problems

Lecture 25 - Numerical Problem MCQ

Lecture 26 - Numerical Problem Milling of Helical Gears

Lecture 27 - Simple and Compound Indexing

Lecture 28 - Differential Indexing

Lecture 29 - Helical Gear Cutting on Milling Machine

Lecture 30 - Numerical Problems on Gear Milling

Lecture 31 - Gear Shaping - I

[Lecture 32 - Gear Shaping - II](#)

[Lecture 33 - Gear Shaping - III](#)

[Lecture 34 - Gear Shaping - IV](#)

[Lecture 35 - Gear Hobbing - I](#)

[Lecture 36 - Gear Hobbing - II](#)

[Lecture 37 - Gear Hobbing - III](#)

[Lecture 38 - Gear Hobbing - IV](#)

[Lecture 39 - Gear Hobbing - V](#)

[Lecture 40 - Gear Hobbing - VI](#)

[Lecture 41 - Introduction to computer control role of computers in automation](#)

[Lecture 42 - Introduction \(Continued...\) binary logic and logic gates](#)

[Lecture 43 - Classification of Computer numerical control \(CNC\) Point to point and continuous control](#)

[Lecture 44 - Classification \(Continued...\) : Closed loop and open loop control](#)

[Lecture 45 - Tutorial involving simple calculations on different aspects of CNC controls](#)

[Lecture 46 - Questions, MCQ Discussions on Motors, Encoders, Decoders and Programming Practice](#)

[Lecture 47 - Stepper motors, Permanent magnet DC motors](#)

[Lecture 48 - Binary circuits and decoders](#)

[Lecture 49 - Tachogenerator, printed circuit motors, Encoders](#)

[Lecture 50 - Programming Practice - I](#)

[Lecture 51 - Programming Practice - II](#)

[Lecture 52 - Computer Aided Offline Programming](#)

[Lecture 53 - Interpolators - Linear](#)

[Lecture 54 - Interpolators - Curvilinear](#)

[Lecture 55 - Questions on Programming and Interpolation](#)

[Lecture 56 - 3-D Machining - Basic Concepts](#)

[Lecture 57 - Curved Surface Geometry](#)

[Lecture 58 - Cutter Path Generation for Curved Surfaces](#)

[Lecture 59 - Cutter Path Generation \(Concluding Part\) and Current Status - CNC Machining and Related Processes](#)

[Lecture 60 - Questions and Discussions on Curved Surface Machining](#)

[Lecture 1 - Introduction](#)

[Lecture 2 - Introduction \(Continued...\)](#)

[Lecture 3 - Introduction \(Continued...\)](#)

[Lecture 4 - Introduction \(Continued...\)](#)

[Lecture 5 - Introduction \(Continued...\)](#)

[Lecture 6 - Elements of Calculation of Variations - I](#)

[Lecture 7 - Elements of Calculation of Variations - II](#)

[Lecture 8 - Elements of Calculation of Variations - III](#)

[Lecture 9 - Strong Form and Weak Form](#)

[Lecture 10 - Rayleigh - Ritz Method - I](#)

[Lecture 11 - Rayleigh - Ritz Method - II](#)

[Lecture 12 - Weighted Residual Method](#)

[Lecture 13 - Weighted Residual Method - Example](#)

[Lecture 14 - Concepts of Element and Axial Bar Problem](#)

[Lecture 15 - Axial Bar Problem](#)

[Lecture 16 - Axial Bar - II](#)

[Lecture 17 - Beam Formulation](#)

[Lecture 18 - Beam Stiffness Matrix](#)

[Lecture 19 - Problems](#)

[Lecture 20 - Beam Column](#)

[Lecture 21 - Problem](#)

[Lecture 22 - Share Deformable Beam Theory](#)

[Lecture 23 - Weak Form and Discretization](#)

[Lecture 24 - Reduced Integration Based Stiffness Matrix](#)

[Lecture 25 - Problem](#)

[Lecture 26 - Problem \(Continued...\)](#)

[Lecture 27 - Element of Formulation](#)

[Lecture 28 - Analysis of Plane Truss](#)

[Lecture 29 - Analysis of Plane Truss \(Computer Implementation\)](#)

[Lecture 30 - Analysis of Euler-Bernoulli Beam \(Computer Implementation\)](#)

[Lecture 31 - Analysis of Plane Frame \(Computer Implementation\)](#)

- Lecture 32 - Introduction to FEM in 2D
- Lecture 33 - Continuity and Completeness
- Lecture 34 - Shape Functions
- Lecture 35 - Numerical Integration (Gaussian Quadrature)
- Lecture 36 - Gaussian Quadrature in two dimension
- Lecture 37 - Weak Form
- Lecture 38 - Example
- Lecture 39 - Iso-Parametric Formulation
- Lecture 40 - Example with Quadrilateral Element
- Lecture 41 - Computer Implementation
- Lecture 42 - 2D Elasticity and Weak Form
- Lecture 43 - Weak Form and Matrix Formulation
- Lecture 44 - Weak Form to Matrix Form
- Lecture 45 - Problems
- Lecture 46 - Thermoelastic Problem
- Lecture 47 - Torsion
- Lecture 48 - Triangular Elements
- Lecture 49 - Triangular Elements (Continued...)
- Lecture 50 - Examples and Computer Implementation
- Lecture 51 - Examples and Computer Implementation (Continued...)
- Lecture 52 - Shear Locking
- Lecture 53 - Selective reduced Integration and Modes of Q4 Element
- Lecture 54 - Incompatible Elements
- Lecture 55 - Nearly Incompressible Material
- Lecture 56
- Lecture 57 - B-Bar Method
- Lecture 58 - Different Elements
- Lecture 59 - Iso-parametric Formulation and Gauss Quadrature
- Lecture 60 - Closure



Lecture 1 - Introduction to product engineering

Lecture 2 - Introduction to Product design

Lecture 3 - Introduction to Design Thinking

Lecture 4 - Conceptual Design

Lecture 5 - Design Planning and Innovation Engineering

Lecture 6 - FFE Interface with HLD and DT

Lecture 7 - High Level Design in the Context of Front End Innovation

Lecture 8 - Functional and Physical Decomposition and QFD

Lecture 9 - Product Design Specification

Lecture 10 - FAST in Functional Design

Lecture 11 - Design Thinking and Product Conceptualization and Development

Lecture 12 - Product specification and related methods

Lecture 13 - Conceptual design stemmed from Idea generation

Lecture 14 - Conceptual design: tools and techniques

Lecture 15 - Quality Function Deployment (QFD): Example

Lecture 16 - Kano Model and Analysis

Lecture 17 - Concept Generation methods

Lecture 18 - Concept evaluation methods

Lecture 19 - Concept testing methods

Lecture 20 - Morphological Design Concept

Lecture 21 - Embodiment, Architectural, Configuration, and Parametric Design

Lecture 22 - Pugh Method (Concept Selection leading to Embodiment Design)

Lecture 23 - Introduction to Sustainability

Lecture 24 - Sustainability and Eco-design

Lecture 25 - LCA and design thinking on LCA

Lecture 26 - Introduction to Additive Manufacturing

Lecture 27 - Design for Rapid prototyping, DFAM

Lecture 28 - Introduction to Design for Manufacturing (DFM) and Assembly (DFA)

Lecture 29 - Rapid: Digital Prototyping

Lecture 30 - A Primer on Design for Quality: Robust and Reliability Engineering

Lecture 31 - Tolerance Design: Taguchi Robust Engineering

[Lecture 32 - Complexity Mitigation in Multidisciplinary, System: Concurrent Engineering Precepts](#)

[Lecture 33 - Design Thinking steps](#)

[Lecture 34 - Design Thinking Methodologies and Tools](#)

[Lecture 35 - Frugal Engineering-A Disruptive Innovation Paradigm in Product Design and Development](#)

[Lecture 36 - Design-Driven Innovation](#)

[Lecture 37 - User interface and Experience \(UI/UX\) Design in Product Engineering](#)

[Lecture 38 - Industrial Design: Aesthetics and Ergonomics](#)

[Lecture 39 - Design Thinking in Industrial Design - Case Studies](#)

[Lecture 40 - Product Engineering'- Led Technology Entrepreneurship](#)

[Lecture 1 - Introduction to Microfluidics](#)

[Lecture 2 - Introduction to Microfluidics \(Continued...\)](#)

[Lecture 3 - Introduction to Microfluidics \(Continued...\)](#)

[Lecture 4 - Introduction to Microfluidics \(Continued...\)](#)

[Lecture 5 - Introduction to Microfluidics \(Continued...\)](#)

[Lecture 6 - Introduction to Microfluidics \(Continued...\)](#)

[Lecture 7 - Introduction to Microfluidics \(Continued...\)](#)

[Lecture 8 - Introduction to Microfluidics \(Continued...\)](#)

[Lecture 9 - Introduction to Microfluidics \(Continued...\)](#)

[Lecture 10 - Introduction to Microfluidics \(Continued...\)](#)

[Lecture 11 - Introduction to Microfluidics \(Continued...\)](#)

[Lecture 12 - Foundations of Fluid Dynamics](#)

[Lecture 13 - Foundations of Fluid Dynamics \(Continued...\)](#)

[Lecture 14 - Foundations of Fluid Dynamics \(Continued...\)](#)

[Lecture 15 - Foundations of Fluid Dynamics \(Continued...\)](#)

[Lecture 16 - Foundations of Fluid Dynamics \(Continued...\)](#)

[Lecture 17 - Foundations of Fluid Dynamics \(Continued...\)](#)

[Lecture 18 - Foundations of Fluid Dynamics \(Continued...\)](#)

[Lecture 19 - Foundations of Fluid Dynamics \(Continued...\)](#)

[Lecture 20 - Foundations of Fluid Dynamics \(Continued...\)](#)

[Lecture 21 - Foundations of Fluid Dynamics \(Continued...\)](#)

[Lecture 22 - Pressure-driven Microchannel Flows](#)

[Lecture 23 - Pressure-driven Microchannel Flows \(Continued...\)](#)

[Lecture 24 - Pressure-driven Microchannel Flows \(Continued...\)](#)

[Lecture 25 - Pressure-driven Microchannel Flows \(Continued...\)](#)

[Lecture 26 - Pressure-driven Microchannel Flows \(Continued...\)](#)

[Lecture 27 - Insights on Inertia-free Flows](#)

[Lecture 28 - Inertia-free Flow in Circular Capillaries and Generalizing the Force balance](#)

[Lecture 29 - Inertia-free flows for general fluids - Concepts for Microelectric Materials](#)

[Lecture 30 - Microelectric Fluid Flow through Microchannel](#)

[Lecture 31 - Fluid Flow through Deformable Microchanel](#)

[Lecture 32 - Fluid Flow through Deformable Microchanel \(Continued...\)](#)

[Lecture 33 - Lubrication Theory](#)

[Lecture 34 - Lubrication Theory \(Continued...\)](#)

[Lecture 35 - Lubrication Theory \(Continued...\)](#)

[Lecture 36 - Lubrication Theory \(Continued...\)](#)

[Lecture 37 - Lubrication Theory \(Continued...\)](#)

[Lecture 38 - Lubrication Theory - 2 Dimensional Problems](#)

[Lecture 39 - Unsteady Flows](#)

[Lecture 40 - Unsteady Flows \(Continued...\)](#)

[Lecture 41 - Unsteady Flows: Stoke's 1st problem \(Continued...\)](#)

[Lecture 42 - Unsteady Flows: Stoke's 1st problem \(Continued...\)](#)

[Lecture 43 - Unsteady Flows: Stoke's 2nd Problem](#)

[Lecture 44 - Unsteady Flows: Stoke's 2nd Problem \(Continued...\)](#)

[Lecture 45 - Unsteady Flows: Stoke's 2nd Problem \(Continued...\)](#)

[Lecture 46 - Stokes Flow Past a Sphere](#)

[Lecture 47 - Stokes Flow Past a Sphere](#)

[Lecture 48 - Stokes Flow Past a Sphere - The Drag Force](#)

[Lecture 49 - Surface Tension and Its Implications in Mircrofluidics](#)

[Lecture 50 - Equilibrium of a Droplet](#)

[Lecture 51 - Equilibrium of a Droplet \(Continued...\)](#)

[Lecture 52 - Capillary Rise](#)

[Lecture 53 - Capillary Filling Dynamics](#)

[Lecture 54 - Capillary Filling Dynamics \(Continued...\)](#)

[Lecture 55 - Capillary Filling Dynamics \(Continued...\)](#)

[Lecture 56 - Capillary Filling Dynamics \(Continued...\)](#)

[Lecture 57 - Factors affecting Capillary and Wetting](#)

[Lecture 58 - Electrowetting](#)

[Lecture 59 - Slip Boundary Condition](#)

[Lecture 60 - Apparent Slip](#)

[Lecture 61 - Thin Film Flows](#)

[Lecture 62 - Thin Film Flows \(Continued...\)](#)

[Lecture 63 - Electrokinetics and Electric Double Layer](#)

[Lecture 64 - Equilibrium within Electrical Double Layer Poisson Boltzmann model](#)

[Lecture 65 - Poisson - Nernst - Plank Model](#)

[Lecture 66 - Maxwell Stress and Electroosmosis](#)

[Lecture 67 - Electroosmosis](#)

[Lecture 68 - Electrophoresis and Streaming Potential](#)

Lecture 1 - Introduction to and Industrial Robots

Lecture 2 - Anatomy of an Industrial Robot

Lecture 3 - Technical Specifications of an Industrial Robot

Lecture 4 - Classification of Robots

Lecture 5 - Fixed Installation Robots - Serial and Parallel Robots

Lecture 6 - Introduction to Industrial Controllers, Drives and Systems

Lecture 7 - DC Motors/Actuators and Drives

Lecture 8 - Stepper Motors

Lecture 9 - Brushless DC Motors/Actuators

Lecture 10 - AC Servo Motors

Lecture 11 - Introduction to Sensor and Transducers, Position Sensors

Lecture 12 - Position Sensors: Potentiometers, and Hall-effect. Velocity Sensors

Lecture 13 - Acceleration Sensors, AC Sensors (Resolvers and Synchronos)

Lecture 14 - Non-contact (Inductive and Capacitive), Force/Torque Sensors

Lecture 15 - Limit Switches, Classification and Characteristics of Sensors

Lecture 16 - Degrees of Freedom and Kinematic Transformations : Translation

Lecture 17 - Pure Rotation, Arbitrary Axis Rotations, Euler Angles

Lecture 18 - Link and Joint Parameters (DH Notations), 2 and 3 DoF Robots

Lecture 19 - 3 DoF Cylindrical Robot (Spatial), SphericalWrist, Cylindrical Robot with Wrist

Lecture 20 - Forward Kinematics of 6-DoF Industrial Robot

Lecture 21 - Inverse Kinematics: 2 and 3 DoF Planar Manipulator

Lecture 22 - Spatial Robots - 3R, Cylindrical (RPP), 4-DoF SCARA Robot

Lecture 23 - Inverse Kinematics of a 6-DoF Industrial Robot

Lecture 24 - Differential Motion Analysis, Velocity, and Robot Jacobian

Lecture 25 - Jacobian (2R), Jacobian Inverse, Singularity, and Acceleration Analysis

Lecture 26 - Installing the Mechanical Arm and Test Run

Lecture 27 - Mastering an Industrial Robot

Lecture 28 - TCP Calibration using 4-Point method and External reference method

Lecture 29 - TCP Orientation Calibration using World Frame and Two-Point method

Lecture 30 - Worksurface Calibration

Lecture 31 - Fixed Tool Calibration: External TCP and Workpiece Calibration

Lecture 32 - Base Linear Track and External Turn-Table Calibration

Lecture 33 - Link Forces and Moments

Lecture 34 - Gravity Compensation and External Forces/Torques

Lecture 35 - Kinetostatic Measures for Robot Design

Lecture 36 - Introduction to Dynamics, LE Approach, Dynamics of 1DoF System

Lecture 37 - Equation of Motion (EoM) for a Two-Link Manipulator using LE

Lecture 38 - Newton-Euler (NE) Approach

Lecture 39 - Equation of motion of a Two-Link manipulator using NE Approach

Lecture 40 - Payload and Supplementary Load Calibration

Lecture 41 - Identification Experiments

Lecture 42 - Repeatability Tests and ISO 9283:1998

Lecture 43 - Introduction to Control, Linear Control, Second Order System

Lecture 44 - Response of a Second Order Linear System

Lecture 45 - Transfer Function and State-space representation, ODE

Lecture 46 - A Robot Joint : DC Motor Model

Lecture 47 - Feedback control of a robot arm, PID Control, Gain Tuning

Lecture 48 - Workspace and Operator Safety

Lecture 49 - Industrial Robot Programming

Lecture 50 - Course Conclusion and Suggestions

Lecture 1 - Introduction

Lecture 2 - Hydrogen Properties

Lecture 3 - Slush Hydrogen, Ortho-Para H<sub>2</sub>

Lecture 4 - Ortho-Para H<sub>2</sub> Conversion

Lecture 5 - Deuterium Production

Lecture 6 - Hydrogen Production - 1

Lecture 7 - Hydrogen Production - 2

Lecture 8 - Hydrogen Production - 3

Lecture 9 - Hydrogen Production

Lecture 10 - Hydrogen Production

Lecture 11 - Hydrogen Production (Electrolysis)

Lecture 12 - Electrolytic Hydrogen

Lecture 13 - Electrolytic Hydrogen

Lecture 14 - SPE Water Electrolyser

Lecture 15 - Thermochemical Process

Lecture 16 - Hydrogen Storage: Overview

Lecture 17 - Compressed Hydrogen Storage

Lecture 18 - Compressed Hydrogen Storage

Lecture 19 - Overview on Hydrogen Storage

Lecture 20 - Adsorption Storage of Hydrogen

Lecture 21 - Basics of Cryogenic Liquefaction

Lecture 22 - Coefficient of Expansion

Lecture 23 - Cryogenic Liquefaction Cycles

Lecture 24 - Cryogenic Liquefaction (Continued...)

Lecture 25 - Hydrogen Liquefaction

Lecture 26 - Cryogenic Liquefaction (Continued...)

Lecture 27 - Cryogenic Liquefaction - Numerical

Lecture 28 - Cryogenic Liquefaction - Numerical

Lecture 29 - Cryogenic Liquefaction (Continued...)

Lecture 30 - Cryogenic Liquefaction (Continued...)

Lecture 31 - Cryo Hydrogen Storage



[Lecture 32 - Cryo Hydrogen Storage](#)

[Lecture 33 - Cryo Hydrogen Storage](#)

[Lecture 34 - Cryogenic Liquid Level Measurement](#)

[Lecture 35 - Flow Rate/Fluid Quality Measurement](#)

[Lecture 36 - Temperature Measurement](#)

[Lecture 37 - Application: Fuel Cell](#)

[Lecture 38 - Fuel Cell \(Continued...\)](#)

[Lecture 39 - Cryogenic Rocket Propulsion](#)

[Lecture 40 - Hydrogen Safety](#)

Lecture 1 - Introduction to power hydraulics

Lecture 2 - Fundamental theory of power hydraulics

Lecture 3 - Fundamental theory of power hydraulics (Continued...)

Lecture 4 - Hydraulic fluids

Lecture 5 - Hydraulic fluids (Continued...)

Lecture 6 - Introduction to hydraulic pumps

Lecture 7 - Introduction to hydraulic pumps (Continued...)

Lecture 8 - Construction, operation and application of hydraulic pumps

Lecture 9 - Construction, operation and application of hydraulic pumps (Continued...)

Lecture 10 - Construction, operation and application of hydraulic pumps (Continued...)

Lecture 11 - Performance characteristics of hydraulic pumps

Lecture 12 - Performance characteristics of hydraulic pumps (Continued...)

Lecture 13 - Performance characteristics of hydraulic pumps (Continued...)

Lecture 14 - Performance characteristics of hydraulic pumps (Continued...)

Lecture 15 - Performance characteristics of hydraulic pumps (Continued...)

Lecture 16 - Introduction to hydraulic actuators

Lecture 17 - Introduction to hydraulic actuators (Continued...)

Lecture 18 - Rotary actuators

Lecture 19 - Rotary actuators (Continued...)

Lecture 20 - Rotary actuators (Continued...)

Lecture 21 - Linear actuators

Lecture 22 - Linear actuators (Continued...)

Lecture 23 - Performance characteristics of hydraulic actuators

Lecture 24 - Performance characteristics of hydraulic actuators (Continued...)

Lecture 25 - Performance characteristics of hydraulic actuators (Continued...)

Lecture 26 - Introduction to hydraulic valves

Lecture 27 - Theory of control valves - I

Lecture 28 - Theory of control valves - I (Continued...)

Lecture 29 - Theory of control valves - II

Lecture 30 - Theory of control valves - III

Lecture 31 - Theory of control valves - IV

- Lecture 32 - Theory of control valves - IV (Continued...)
- Lecture 33 - Theory of proportional valves
- Lecture 34 - Theory of servo valves
- Lecture 35 - Numerical on operation of control valves
- Lecture 36 - Introduction to hydraulic accessories
- Lecture 37 - Hydraulic accumulator
- Lecture 38 - Hydraulic reservoirs
- Lecture 39 - Hoses, Filters and Coolers
- Lecture 40 - Performance analysis of hydraulic accumulators and hydraulic reservoirs
- Lecture 41 - Hydrostatic Transmission System (HST)
- Lecture 42 - Hydraulic system for industrial equipment - I
- Lecture 43 - Hydraulic system for industrial equipment - I (Continued...)
- Lecture 44 - Hydraulic system for industrial equipment - I (Continued...)
- Lecture 45 - Hydraulic system for industrial equipment - I (Continued...)
- Lecture 46 - Hydraulic system for industrial equipment - II
- Lecture 47 - Hydraulic system for industrial equipment - II (Continued...)
- Lecture 48 - Hydraulic system for industrial equipment - II (Continued...)
- Lecture 49 - Performance evaluation of hydraulic systems
- Lecture 50 - Performance evaluation of hydraulic systems (Continued...)
- Lecture 51 - Introduction to control system
- Lecture 52 - Introduction to control system (Continued...)
- Lecture 53 - Control system analysis - I
- Lecture 54 - Control system analysis - I (Continued...)
- Lecture 55 - Control system analysis - I (Continued...)
- Lecture 56 - Control system analysis - II
- Lecture 57 - Control system analysis - II (Continued...)
- Lecture 58 - Control system analysis - II (Continued...)
- Lecture 59 - Digital hydraulics
- Lecture 60 - Digital hydraulics (Continued...)

**NPTEL : Advanced Gas Dynamics (Mechanical Engineering)**

**Co-ordinators : Dr. Rinku Mukherjee**

- Lecture 1 - Introduction to Gas Dynamics & Review of Basic Thermodynamics
- Lecture 2 - Review of Basic Thermodynamics Continued
- Lecture 3 - An introduction to Normal Shocks
- Lecture 4 - The Mach Number and Compressible Flow
- Lecture 5 - The relation of physical properties across a normal shock
- Lecture 6 - Normal Shock in a duct: Throat and Reservoir conditions
- Lecture 7 - Example Problems in Normal Shocks
- Lecture 8 - An introduction to Oblique Shocks
- Lecture 9 - The relation of physical properties across an oblique shock
- Lecture 10 - Example Problems in Oblique Shocks
- Lecture 11 - Pressure - Deflection relationship of Shocks
- Lecture 12 - An introduction to Expansion waves
- Lecture 13 - Area - Mach Relationship
- Lecture 14 - Unsteady Shock Waves: The Shock Tube
- Lecture 15 - The Shock Tube: Propagating Normal Shock and its reflection from end wall
- Lecture 16 - A review of wave propagation
- Lecture 17 - Wave propagation: Small Perturbation Theory
- Lecture 18 - Finite Wave Theory: An introduction to the Method of Characteristics
- Lecture 19 - The Shock Tube: Propagating Expansion Fan
- Lecture 20 - The Method of Characteristics
- Lecture 21 - Application of The Method of Characteristics: Design of a minimum length nozzle
- Lecture 22 - Application of The Method of Characteristics: Flow through a diverging channel
- Lecture 23 - Flow over a Wavy wall: Formulation using Perturbation Theory
- Lecture 24 - Subsonic Flow over a Wavy wall
- Lecture 25 - Supersonic Flow over a Wavy wall
- Lecture 26 - Supersonic Flow past a 3D Cone: Axisymmetric/Quasi 2D Flow
- Lecture 27 - Quasi 2D Flow - I
- Lecture 28 - Quasi 2D Flow - II
- Lecture 29 - Similarity Rules and Transformed Coordinate System
- Lecture 30 - Critical Mach Number and Thin Airfoil Theory
- Lecture 31 - Example Problem using Thin Airfoil Theory

[Lecture 32 - Example Problems - 1](#)

[Lecture 33 - Example Problems - 2](#)

[Lecture 34 - Example Problems - 3](#)

[Lecture 35 - Supersonic Flow past a 3D Cone at an angle of attack](#)

[Lecture 36 - Supersonic Flow past a 3D Cone at an angle of attack: Flow Visualization - I](#)

[Lecture 37 - Supersonic Flow past a 3D Cone at an angle of attack: Flow Visualization - II](#)

[Lecture 38 - Supersonic Flow past a 3D Cone at an angle of attack: Governing Equations](#)

[Lecture 39 - Supersonic Flow past a 3D Cone at an angle of attack: Numerical Procedure](#)

[Lecture 40 - Supersonic Flow past a 3D Bluff Body at an angle of attack](#)

Lecture 1 - Introduction to Optimization

Lecture 2 - System Design and Analysis

Lecture 3 - Workable system

Lecture 4 - System simulation

Lecture 5 - Information flow diagrams

Lecture 6 - Successive substitution method

Lecture 7 - Successive substitution method (Continued.)

Lecture 8 - Successive substitution method and Newton-Raphson method

Lecture 9 - Newton-Raphson method (Continued.)

Lecture 10 - Convergence characteristics of Newton-Raphson method

Lecture 11 - Newton-Raphson method for multiple variables

Lecture 12 - Solution of system of linear equations

Lecture 13 - Introduction to Curve fitting

Lecture 14 - Example for Lagrange interpolation

Lecture 15 - Lagrange interpolation (Continued.)

Lecture 16 - Best fit

Lecture 17 - Least Square Regression

Lecture 18 - Least Square Regression (Continued.)

Lecture 19 - Least Square Regression (Continued.)

Lecture 20 - Non-linear Regression (Gauss - Newton Algorithm)

Lecture 21 - Optimization- Basic ideas

Lecture 22 - Properties of objective function and cardinal ideas in optimization

Lecture 23 - Unconstrained optimization

Lecture 24 - Constrained optimization problems

Lecture 25 - Mathematical proof of the Lagrange multiplier method

Lecture 26 - Test for Maxima / Minima

Lecture 27 - Handling in-equality constraints

Lecture 28 - Kuhn-Tucker conditions (Continued.)

Lecture 29 - Uni-modal function and search methods

Lecture 30 - Dichotomous search

Lecture 31 - Fibonacci search method

[Lecture 32 - Reduction ratio of Fibonacci search method](#)

[Lecture 33 - Introduction to multi-variable optimization](#)

[Lecture 34 - The Conjugate gradient method](#)

[Lecture 35 - The Conjugate gradient method \(Continued.\)](#)

[Lecture 36 - Linear programming](#)

[Lecture 37 - Dynamic programming](#)

[Lecture 38 - Genetic Algorithms](#)

[Lecture 39 - Genetic Algorithms \(Continued.\)](#)

[Lecture 40 - Simulated Annealing and Summary](#)

Lecture 1 - EFM Course Outline

Lecture 2 - Spectacular Failures

Lecture 3 - Lessons from Spectacular Failures

Lecture 4 - LEFM and EPFM

Lecture 5 - Fracture Mechanics is Holistic

Lecture 6 - Fatigue Crack Growth Model

Lecture 7 - Crack Growth and Fracture Mechanisms

Lecture 8 - Elastic Strain Energy

Lecture 9 - Fracture Strength by Griffith

Lecture 10 - Energy Release Rate

Lecture 11 - Utility of Energy Release Rate

Lecture 12 - Pop-in Phenomenon

Lecture 13 - Displacement and Stress Formulations

Lecture 14 - Forms of Stress Functions

Lecture 15 - Airy's Stress Function for Mode-I

Lecture 16 - Westergaard Solution of Stress Field for Mode-I

Lecture 17 - Displacement Field for Mode-I

Lecture 18 - Relation between KI and GI

Lecture 19 - Stress Field in Mode-II

Lecture 20 - Generalised Westergaard Approach

Lecture 21 - William's Eigen Function Approach

Lecture 22 - Multi-parameter Stress Field Equations

Lecture 23 - Validation of Multi-parameter Field Equations

Lecture 24 - Discussion Session - I

Lecture 25 - Evaluation of SIF for Various Geometries

Lecture 26 - SIF for Embedded Cracks

Lecture 27 - SIF for Surface Cracks

Lecture 28 - Modeling of Plastic Deformation

Lecture 29 - Irwin's Model

Lecture 30 - Dugdale Model

Lecture 31 - Fracture Toughness Testing



[Lecture 32 - Plane Strain Fracture Toughness Testing](#)

[Lecture 33 - Plane Stress Fracture Toughness Testing](#)

[Lecture 34 - Paris Law and Sigmoidal Curve](#)

[Lecture 35 - Crack Closure](#)

[Lecture 36 - Crack Growth Models](#)

[Lecture 37 - J-Integral](#)

[Lecture 38 - HRR Field and CTOD](#)

[Lecture 39 - FAD and Mixed Mode Fracture](#)

[Lecture 40 - Crack Arrest and Repair Methodologies](#)

[Lecture 41 - Discussion Session - II](#)

Lecture 1 - Overview of Experimental Stress Analysis

Lecture 2 - Optical Methods Work as Optical Computers

Lecture 3 - Stress, Strain and Displacement Fields

Lecture 4 - Physical Principle of Strain Gauges, Photoelasticity and Moiré

Lecture 5 - Introduction to Moiré, Brittle Coatings and Holography

Lecture 6 - Hologram Interferometry, Speckle Methods

Lecture 7 - Introduction to Shearography, TSA, DIC and Caustics

Lecture 8 - Fringe Patterns – Richness of Qualitative Information

Lecture 9 - Multi-Scale Analysis in Experimental Mechanics

Lecture 10 - Selection of an Experimental Technique

Lecture 11 - Introduction to Transmission Photoelasticity

Lecture 12 - Ordinary and Extraordinary Rays

Lecture 13 - Light Ellipse, Passage of Light Through a Crystal Plate

Lecture 14 - Retardation Plates, Stress-optic Law

Lecture 15 - Plane Polariscopes

Lecture 16 - Jones Calculus

Lecture 17 - Circular Polariscopes

Lecture 18 - Determination of Photoelastic Parameters at an Arbitrary Point

Lecture 19 - Tardy's Method of Compensation

Lecture 20 - Calibration of Photo elastic Materials

Lecture 21 - Fringe Thinning Methodologies

Lecture 22 - Fringe Ordering in Photoelasticity

Lecture 23 - Miscellaneous Topics in Transmission Photoelasticity

Lecture 24 - Three Dimensional Photoelasticity

Lecture 25 - Overview of Digital Photoelasticity

Lecture 26 - Introduction to Photoelastic Coatings

Lecture 27 - Correction Factors for Photoelastic Coatings

Lecture 28 - Coating Materials, Selection of Coating Thickness, Industrial Application of Photoelastic Coatings

Lecture 29 - Calibration of Photoelastic Coatings, Introduction to Brittle Coatings

Lecture 30 - Analysis of Brittle Coatings

Lecture 31 - Introduction to Strain Gauges

[Lecture 32 - Strain Sensitivity of a Strain Gauge, Bridge Sensitivity, Rosettes](#)

[Lecture 33 - Strain Gauge Alloys, Carriers and Adhesives](#)

[Lecture 34 - Performance of Strain Gauge System](#)

[Lecture 35 - Temperature Compensation, Two-wire and Three-wire Circuits](#)

[Lecture 36 - Strain Gauge Selection](#)

[Lecture 37 - Bonding of a Strain Gauge](#)

[Lecture 38 - Soldering, Accounting for Transverse Sensitivity Effects](#)

[Lecture 39 - Correction Factors for Special Applications](#)

[Lecture 40 - Special Gauges](#)

[Lecture 41 - Questions and Answers](#)

**NPTEL : Rocket Propulsion (Mechanical Engineering)**

**Co-ordinators : Prof. K. Ramamurthi**

Lecture 1 - Introduction

Lecture 2 - Motion in Space

Lecture 3 - Rotational Frame of Reference and Orbital Velocities

Lecture 4 - Velocity Requirements

Lecture 5 - Theory of Rocket Propulsion

Lecture 6 - Rocket Equation and Staging of Rockets

Lecture 7 - Review of Rocket Principles; Propulsion Efficiency

Lecture 8 - Examples Illustrating Theory of Rocket Propulsion and Introduction to Nozzles

Lecture 9 - Theory of Nozzles

Lecture 10 - Nozzle Shape

Lecture 11 - Area Ratio of Nozzles; Under-expansion and Over-expansion

Lecture 12 - Characteristic Velocity and Thrust Coefficient

Lecture 13 - Divergence Loss in Conical Nozzles and the Bell Nozzle

Lecture 14 - Unconventional Nozzles and Problems in Nozzles

Lecture 15 - Criterion for Choice of Chemical Propellants

Lecture 16 - Choice of Fuel-Rich Propellants

Lecture 17 - Performance Prediction Analysis

Lecture 18 - Dissociation of Products of Combustion

Lecture 19 - Shifting Equilibrium and Frozen Flow in Nozzles

Lecture 20 - Factors Influencing Choice of Chemical Propellants

Lecture 21 - Low Energy Liquid Propellants and Hybrid Propellants

Lecture 22 - Introduction to Solid Propellant Rockets

Lecture 23 - Burn Rate of Solid Propellants and Equilibrium Pressure in Solid Propellant Rockets

Lecture 24 - Design Aspects of Solid Propellant Rockets

Lecture 25 - Burning Surface Area of Solid Propellant Grains

Lecture 26 - Ignition of Solid Propellant Rockets

Lecture 27 - Review of Solid Propellant Rockets

Lecture 28 - Feed Systems for Liquid Propellant Rockets

Lecture 29 - Feed System Cycles for Pump Fed Liquid Propellant Rockets

Lecture 30 - Analysis of Gas Generator and Staged Combustion Cycles and Introduction to Injectors

Lecture 31 - Injectors, Cooling of Chamber and Mixture Ratio Distribution

[Lecture 32 - Efficiencies due to Mixture Ratio Distribution and Incomplete Vaporization](#)

[Lecture 33 - Pumps and Turbines; Propellant Feed System at Zero  \$\Omega\$  Conditions](#)

[Lecture 34 - Review of Liquid Bi-propellant Rockets and Introduction to Mono-propellant Rockets](#)

[Lecture 35 - Introduction to Hybrid Rockets and a Simple Illustration of Combustion Instability in Liquid Propellant Rockets](#)

[Lecture 36 - Combustion Instability in Solid Propellant and Liquid Propellant Rockets – Bulk and Wave Modes](#)

[Lecture 37 - Wave modes of Oscillation](#)

[Lecture 38 - Mechanisms Causing Instabilities and Strategies for Avoiding Combustion Instability](#)

[Lecture 39 - Electric and Magnetic Fields and the Electrostatic Thruster](#)

[Lecture 40 - Electrical Thrusters](#)

[Lecture 41 - Advances in Rocket Propulsion](#)

- Lecture 1 - Advanced Finite Elements Analysis
- Lecture 2 - Advanced Finite Elements Analysis
- Lecture 3 - Advanced Finite Elements Analysis
- Lecture 4 - Advanced Finite Elements Analysis
- Lecture 5 - Advanced Finite Elements Analysis
- Lecture 6 - Advanced Finite Elements Analysis
- Lecture 7 - Advanced Finite Elements Analysis
- Lecture 8 - Advanced Finite Elements Analysis
- Lecture 9 - Advanced Finite Elements Analysis
- Lecture 10 - Advanced Finite Elements Analysis
- Lecture 11 - Advanced Finite Elements Analysis
- Lecture 12 - Advanced Finite Elements Analysis
- Lecture 13 - Advanced Finite Elements Analysis
- Lecture 14 - Advanced Finite Elements Analysis
- Lecture 15 - Advanced Finite Elements Analysis
- Lecture 16 - Advanced Finite Elements Analysis
- Lecture 17 - Advanced Finite Elements Analysis
- Lecture 18 - Advanced Finite Elements Analysis
- Lecture 19 - Advanced Finite Elements Analysis
- Lecture 20 - Advanced Finite Elements Analysis
- Lecture 21 - Advanced Finite Elements Analysis
- Lecture 22 - Advanced Finite Elements Analysis
- Lecture 23 - Advanced Finite Elements Analysis
- Lecture 24 - Advanced Finite Elements Analysis
- Lecture 25 - Advanced Finite Elements Analysis
- Lecture 26 - Advanced Finite Elements Analysis
- Lecture 27 - Advanced Finite Elements Analysis
- Lecture 28 - Advanced Finite Elements Analysis
- Lecture 29 - Advanced Finite Elements Analysis
- Lecture 30 - Advanced Finite Elements Analysis

Lecture 1 - Introduction and Linear Programming

Lecture 2 - Revised Simplex Algorithm

Lecture 3 - Simplex Method for Bounded Variables

Lecture 4 - One Dimensional Cutting Stock Problem

Lecture 5 - One Dimensional Cutting Stock Problem (Continued.)

Lecture 6 - Dantzig-Wolfe Decomposition Algorithm

Lecture 7 - Dantzig-Wolfe Decomposition Algorithm Primal-Dual Algorithm

Lecture 8 - Primal-Dual Algorithm

Lecture 9 - Goal Programming-Formulations

Lecture 10 - Goal Programming Solutions Complexity of Simplex Algorithm

Lecture 11 - Complexity of Simplex Algorithm (Continued.) Integer Programming

Lecture 12 - Integer Programming-Formulations

Lecture 13 - Solving Zero-One Problems

Lecture 14 - Solving Zero-One Problems (Continued.)

Lecture 15 - Branch And Bond Algorithm For Integer Programming

Lecture 16 - Cutting Plane Algorithm

Lecture 17 - All Integer Primal Algorithm

Lecture 18 - All Integer Dual Algorithm

Lecture 19 - Network Models

Lecture 20 - Shortest Path Problem

Lecture 21 - Successive Shortest Path Problem

Lecture 22 - Maximum Flow Problem

Lecture 23 - Minimum Cost Flow Problem

Lecture 24 - Traveling Salesman Problem (TSP)

Lecture 25 - Branch and Bound Algorithms for TSP

Lecture 26 - Heuristics for TSP

Lecture 27 - Heuristics for TSP (Continued.)

Lecture 28 - Chinese Postman Problem

Lecture 29 - Vehicle Routeing Problem

Lecture 30 - Queueing Models

Lecture 31 - Single Server Queueing Models

[Lecture 32 - Multiple Server Queueing Models](#)

[Lecture 33 - Game Theory](#)

[Lecture 34 - Critical Path Method](#)

[Lecture 35 - Quadratic Programming](#)

[Lecture 36 - Integer Programming \(Continued.\)](#)

[Lecture 37 - All Integer Dual Algorithm](#)

[Lecture 38 - Mixed Integer Linear Programming](#)

[Lecture 39 - Benders Partitioning Algorithm](#)



Lecture 1 - Introduction to Linear Programming Formulations

Lecture 2 - Linear Programming Formulations (Continued...)

Lecture 3 - Linear Programming Solutions- Graphical Methods

Lecture 4 - Linear Programming Solutions - Simplex Algorithm

Lecture 5 - Simplex Algorithm-Minimization Problems

Lecture 6 - Simplex Algorithm - Initialization and Iteration

Lecture 7 - Simplex Algorithm - Termination

Lecture 8 - Introduction to Duality

Lecture 9 - Primal Dual Relationships, Duality Theorems

Lecture 10 - Dual Variables and the Simplex Tables

Lecture 11 - Simplex Algorithm in Matrix Form Introduction to Sensitivity Analysis

Lecture 12 - Sensitivity Analysis Transportation Problem (Introduction)

Lecture 13 - Transportation Problem, Methods for Initial Basic Feasible Solutions

Lecture 14 - Transportation Problem-Optimal Solutions

Lecture 15 - Transportation Problem - Other Issues

Lecture 16 - Assignment Problem - Hungarian Algorithm

Lecture 17 - Assignment Problem - Other Issues Introduction to Dynamic Programming

Lecture 18 - Dynamic Programming - Examples Involving Discrete Variables

Lecture 19 - Dynamic Programming - Continuous Variables

Lecture 20 - Dynamic Programming - Examples to Solve Linear & Integer Programming Problems

Lecture 21 - Inventory Models - Deterministic Models

Lecture 22 - Inventory Models - Discount Models, Constrained Inventory Problems, Lagrangean Multipliers, Conclusions

[Lecture 1 - Introduction to Finite Element Method](#)

[Lecture 2 - Introduction to Finite Element Method](#)

[Lecture 3 - Introduction to Finite Element Method](#)

[Lecture 4 - Introduction to Finite Element Method](#)

[Lecture 5 - Introduction to Finite Element Method](#)

[Lecture 6 - Introduction to Finite Element Method](#)

[Lecture 7 - Introduction to Finite Element Method](#)

[Lecture 8 - Introduction to Finite Element Method](#)

[Lecture 9 - Introduction to Finite Element Method](#)

[Lecture 10 - Introduction to Finite Element Method](#)

[Lecture 11 - Introduction to Finite Element Method](#)

[Lecture 12 - Introduction to Finite Element Method](#)

[Lecture 13 - Introduction to Finite Element Method](#)

[Lecture 14 - Introduction to Finite Element Method](#)

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[Lecture 16 - Introduction to Finite Element Method](#)

[Lecture 17 - Introduction to Finite Element Method](#)

[Lecture 18 - Introduction to Finite Element Method](#)

[Lecture 19 - Introduction to Finite Element Method](#)

[Lecture 20 - Introduction to Finite Element Method](#)

[Lecture 21 - Introduction to Finite Element Method](#)

[Lecture 22 - Introduction to Finite Element Method](#)

[Lecture 23 - Introduction to Finite Element Method](#)

[Lecture 24 - Introduction to Finite Element Method](#)

[Lecture 25 - Introduction to Finite Element Method](#)

[Lecture 26 - Introduction to Finite Element Method](#)

[Lecture 27 - Introduction to Finite Element Method](#)

[Lecture 28 - Introduction to Finite Element Method](#)

[Lecture 29 - Introduction to Finite Element Method](#)

[Lecture 30 - Introduction to Finite Element Method](#)

[Lecture 31 - Introduction to Finite Element Method](#)

[Lecture 32 - Introduction to Finite Element Method](#)

[Lecture 33 - Introduction to Finite Element Method](#)

Lecture 1 - Introduction to the Study of Mechanical Measurement

Lecture 2 - Errors in Measurement

Lecture 3 - Errors in Measurement (Continued...)

Lecture 4 - Propagation of Errors

Lecture 5 - Regression Analysis

Lecture 6 - Regression Analysis (Continued...)

Lecture 7 - Design of Experiments

Lecture 8 - Design of Experiments (Continued...)

Lecture 9 - Temperature Measurement

Lecture 10 - Overview of Thermometry

Lecture 11 - Thermoelectric Thermometry

Lecture 12 - Thermoelectric Thermometry (Continued...)

Lecture 13 - Measurement of Temperature Under Various Conditions

Lecture 14 - Errors in Temperature Measurement

Lecture 15 - Measurement of Transient Temperature and Resistance Thermometry

Lecture 16 - Resistance Thermometry (Continued...)

Lecture 17 - Resistance Thermometry (Continued...) and pyrometry

Lecture 18 - pyrometry (Continued...)

Lecture 19 - pyrometry (Continued...)

Lecture 20 - Pressure Measurement (Continued...)

Lecture 21 - Pressure Measurement (Continued...)

Lecture 22 - Pressure Measurement (Continued...)

Lecture 23 - Pressure Measurement (Continued...)

Lecture 24 - Transient Response of Pressure Transducers

Lecture 25 - Transient Response of Pressure Transducers

Lecture 26 - Measurement of High Vacuum

Lecture 27 - Measurement of Fluid Velocity

Lecture 28 - Hot Wire Anemometry and Laser Doppler Velocimetry

Lecture 29 - Laser Doppler Velocimetry and Ultrasonic Methods

Lecture 30 - Measurement of Heat Flux

Lecture 31 - Measurement of Heat Flux (Continued...)

- Lecture 32 - Transient Method of Heat Flux Measurement
- Lecture 33 - Measurement of Volume and Mass Flow Rate of Fluid
- Lecture 34 - Flow Measuring Devices
- Lecture 35 - Measurement of Stagnation and Bulk Mean Temperature
- Lecture 36 - Measurement of Thermo-Physical Properties
- Lecture 37 - Measurement of Thermal Conductivity
- Lecture 38 - Measurement of Heat Capacity and Heating Value
- Lecture 39 - Measurement of Viscosity
- Lecture 40 - Measurement of Viscosity (Continued...)
- Lecture 41 - Integrating Sphere and Measurement of Emissivity
- Lecture 42 - Measurements of Gas Composition
- Lecture 43 - Measurements of Gas Composition (Continued...)
- Lecture 44 - Measurements of Gas Composition and Smoke
- Lecture 45 - Measurement of Force
- Lecture 46 - Force Measurement
- Lecture 47 - Vibration and Acceleration Measurement
- Lecture 48 - Laser Doppler Accelerometer, Speed, Torque
- Lecture 49 - General Issues in Mechanical Measurement
- Lecture 50 - Case Studies

**NPTEL : Principles of Mechanical Measurements (Mechanical Engineering)**

**Co-ordinators : Prof. R. Raman**

- Lecture 1 - Principles Of Mechanical Measurements
- Lecture 2 - Principles Of Mechanical Measurements
- Lecture 3 - Principles Of Mechanical Measurements
- Lecture 4 - Principles Of Mechanical Measurements
- Lecture 5 - Principles Of Mechanical Measurements
- Lecture 6 - Principles Of Mechanical Measurements
- Lecture 7 - Principles Of Mechanical Measurements
- Lecture 8 - Principles Of Mechanical Measurements
- Lecture 9 - Principles Of Mechanical Measurements
- Lecture 10 - Principles of Mechanical Measurements
- Lecture 11 - Principles Of Mechanical Measurements
- Lecture 12 - Principles Of Mechanical Measurements
- Lecture 13 - Principles Of Mechanical Measurements
- Lecture 14 - Principles Of Mechanical Measurements
- Lecture 15 - Principles Of Mechanical Measurements
- Lecture 16 - Principles Of Mechanical Measurements
- Lecture 17 - Principles Of Mechanical Measurements
- Lecture 18 - Principles Of Mechanical Measurements
- Lecture 19 - Principles Of Mechanical Measurements
- Lecture 20 - Principles Of Mechanical Measurements
- Lecture 21 - Principles Of Mechanical Measurements
- Lecture 22 - Principles Of Mechanical Measurements
- Lecture 23 - Principles Of Mechanical Measurements
- Lecture 24 - Principles Of Mechanical Measurements
- Lecture 25 - Principles Of Mechanical Measurements
- Lecture 26 - Principles Of Mechanical Measurements

- Lecture 1 - Introduction to sprays and their applications
- Lecture 2 - Spatial versus Temporal Sampling
- Lecture 3 - Spatial Vs Temporal Sampling example problem
- Lecture 4 - Steady vs unsteady spray
- Lecture 5 - Statistical measures on spray
- Lecture 6 - Discussion on pdf and moments
- Lecture 7 - Size velocity correlation
- Lecture 8 - Discussion on Interfacial tension
- Lecture 9 - Introduction to Atomizers and their design - 1
- Lecture 10 - Introduction to Atomizers and their design - 2
- Lecture 11 - Simple measurement techniques
- Lecture 12 - Selection of atomizers
- Lecture 13 - Spray measurement characteristics
- Lecture 14 - Spray measurements techniques
- Lecture 15 - Non-intrusive spray measurements techniques
- Lecture 16 - Non-intrusive spray measurements techniques
- Lecture 17 - Linear stability analysis “ Introduction
- Lecture 18 - Linear stability analysis- Kelvin-Helmholtz instability - 1
- Lecture 19 - Linear stability analysis- Kelvin-Helmholtz instability - 2
- Lecture 20 - Linear stability analysis- Kelvin-Helmholtz instability - 3
- Lecture 21 - Linear stability analysis procedure
- Lecture 22 - Linear stability analysis - Cylindrical jet instability - 1
- Lecture 23 - Linear stability analysis - Cylindrical jet instability - 2
- Lecture 24 - Linear stability analysis - Planar Liquid Sheet instability - 1
- Lecture 25 - Linear stability analysis - Planar Liquid Sheet instability - 2
- Lecture 26 - Design of pressure swirl atomizer - 1
- Lecture 27 - Design of pressure swirl atomizer - 2
- Lecture 28 - Design of pressure swirl atomizer - 3
- Lecture 29 - Design of pressure swirl atomizer - 4
- Lecture 30 - Secondary atomization-Dimensionless parameters
- Lecture 31 - Secondary atomization-Modes of breakup - 1

[Lecture 32 - Secondary atomization-Modes of breakup - 2](#)

[Lecture 33 - Multiphase modelling](#)

[Lecture 34 - Multiphase modelling](#)

[Lecture 35 - Multiphase flow modelling basics](#)

[Lecture 36 - Multiphase modelling “ Selection of model - 1](#)

[Lecture 37 - Multiphase modelling “ Selection of model - 2](#)

[Lecture 38 - Multiphase modelling - Governing equations](#)

[Lecture 39 - Droplet evaporation](#)

[Lecture 40 - Droplet combustion](#)

[Lecture 41 - Spray combustion](#)



Lecture 1 - Importance of Thermal Radiation

Lecture 2 - Blackbody definition

Lecture 3 - Solid angle, spectral radiation intensity

Lecture 4 - Radiation pressure and radiation energy density

Lecture 5 - Relationship between  $\epsilon_{\lambda}$  and  $\epsilon_{T\lambda}$  and Candidate blackbody distribution functions

Lecture 6 - Candidate blackbody distribution functions (Continued...)

Lecture 7 - Planck's blackbody radiation distribution function

Lecture 8 - Planck's distribution and Wien's displacement law

Lecture 9 - Universal blackbody function

Lecture 10 - Emissivity

Lecture 11 - Emissivity (Continued...)

Lecture 12 - Emissivity (Continued...)

Lecture 13 - Kirchoff law, Absorptivity

Lecture 14 - Kirchoff law, Absorptivity (Continued...)

Lecture 15 - Problems on emissivity, absorptivity

Lecture 16 - Reflectivity

Lecture 17 - Transmissivity

Lecture 18 - Problems on reflectivity and transmissivity

Lecture 19 - Radiation heat transfer between surfaces

Lecture 20 - View factor

Lecture 21 - View factor (Continued...)

Lecture 22 - View factor (Continued...)

Lecture 23 - Enclosure analysis

Lecture 24 - Enclosure analysis (Continued...)

Lecture 25 - Enclosure analysis - Gray surface

Lecture 26 - Enclosure analysis - Non gray surfaces

Lecture 27 - Radiation in participating media

Lecture 28 - Solution to the RTE

Lecture 29 - Concept of mean beam length

Lecture 30 - Enclosure analysis in the presence of absorbing / emitting gas

Lecture 31 - Emissivities and absorptivities of Gas mixtures

[Lecture 32 - Conduction - Introduction](#)

[Lecture 33 - Conduction - Energy equation](#)

[Lecture 34 - Conduction - 1D, steady state](#)

[Lecture 35 - Conduction - 1D, heat generation](#)

[Lecture 36 - Fin heat transfer - I](#)

[Lecture 37 - Fin heat transfer - II](#)

[Lecture 38 - Conduction - Cylindrical and Spherical geometries](#)

[Lecture 39 - Transient conduction](#)

[Lecture 40 - Transient conduction \(Continued...\)](#)

[Lecture 41 - Two dimensional steady state conduction](#)

[Lecture 42 - Analytical solution for Laplace equation](#)

[Lecture 43 - Numerical methods in conduction](#)

[Lecture 44 - Numerical methods in conduction \(Continued...\)](#)

[Lecture 45 - Conduction with change of phase](#)

[Lecture 46 - Conduction with change of phase \(Continued...\)](#)

Lecture 1 - Introduction

Lecture 2 - Introduction / Fundamental Ideas

Lecture 3 - Fundamental Ideas

Lecture 4 - Fundamental Ideas

Lecture 5 - Fundamental Ideas / Normal Shock Waves

Lecture 6 - Normal Shock Waves

Lecture 7 - Normal Shock Waves / Rayleigh Flow

Lecture 8 - Rayleigh Flow

Lecture 9 - Rayleigh Flow

Lecture 10 - Rayleigh Flow / Fanno Flow

Lecture 11 - Fanno Flow

Lecture 12 - Fanno Flow

Lecture 13 - Fanno Flow / Quasi One Dimensional Flows

Lecture 14 - Quasi One Dimensional Flows

Lecture 15 - Quasi One Dimensional Flows

Lecture 16 - Quasi One Dimensional Flows

Lecture 17 - Quasi One Dimensional Flows

Lecture 18 - Quasi One Dimensional Flows

Lecture 19 - Quasi One Dimensional Flows

Lecture 20 - Oblique Shock Waves

Lecture 21 - Oblique Shock Waves

Lecture 22 - Oblique Shock Waves

Lecture 23 - Oblique Shock Waves / Prandtl Meyer Waves

Lecture 24 - Prandtl Meyer Waves

Lecture 25 - Prandtl Meyer Waves

Lecture 26 - Propulsion - an Introduction

Lecture 27 - Components of the Gas Turbine Engine

Lecture 28 - Components of the Gas Turbine Engine

Lecture 29 - Components of the Gas Turbine Engine

Lecture 30 - Components of the Gas Turbine Engine

Lecture 31 - Components of the Gas Turbine Engine / Thermodynamic Analysis of the Engine

[Lecture 32 - Thermodynamic Analysis of the Engine](#)

[Lecture 33 - Thermodynamic Analysis of the Engine](#)

[Lecture 34 - Calculations for Thrust and Fuel Consumption](#)

[Lecture 35 - Calculations for Thrust and Fuel Consumption](#)

[Lecture 36 - Calculations for Thrust and Fuel Consumption / Emerging Trends](#)

[Lecture 37 - Emerging Trends / Ramjets](#)

[Lecture 38 - Ramjets](#)

[Lecture 39 - Ramjets / Scramjets](#)

[Lecture 40 - Scramjets](#)

[Lecture 1 - Introduction and Scaling](#)

[Lecture 2 - Scaling](#)

[Lecture 3 - Micro-scale fluid mechanics](#)

[Lecture 4 - Micro-scale fluid mechanics \(Continued...\)](#)

[Lecture 5 - Micro-scale fluid mechanics \(Continued...\)](#)

[Lecture 6 - Micro-scale fluid mechanics \(Continued...\)](#)

[Lecture 7 - Micro-scale fluid mechanics \(Continued...\)](#)

[Lecture 8 - Micro-scale fluid mechanics \(Continued...\)](#)

[Lecture 9 - Micro-scale fluid mechanics \(Continued...\)](#)

[Lecture 10 - Micro-scale fluid mechanics \(Continued...\)](#)

[Lecture 11 - Capillary Flows](#)

[Lecture 12 - Capillary Flows \(Continued...\)](#)

[Lecture 13 - Capillary Flows and Electrokinetics](#)

[Lecture 14 - Electrokinetics](#)

[Lecture 15 - Electrokinetics \(Continued...\)](#)

[Lecture 16 - Electrokinetics \(Continued...\)](#)

[Lecture 17 - Electrokinetics \(Continued...\)](#)

[Lecture 18 - Electrokinetics \(Continued...\)](#)

[Lecture 19 - Electrokinetics \(Continued...\)](#)

[Lecture 20 - Electrokinetics and Magnetophoresis](#)

[Lecture 21 - Microfabrication Techniques](#)

[Lecture 22 - Microfabrication Techniques \(Continued...\)](#)

[Lecture 23 - Microfabrication Techniques \(Continued...\)](#)

[Lecture 24 - Microfabrication Techniques \(Continued...\)](#)

[Lecture 25 - Microfabrication Techniques \(Continued...\)](#)

[Lecture 26 - Microfabrication Techniques \(Continued...\)](#)

[Lecture 27 - Microfabrication Techniques \(Continued...\)](#)

[Lecture 28 - Microfabrication Techniques \(Continued...\)](#)

[Lecture 29 - Micropump](#)

[Lecture 30 - Micropump \(Continued...\)](#)

[Lecture 31 - Microvalve](#)

[Lecture 32 - Microvalve \(Continued...\)](#)

[Lecture 33 - Microvalve \(Continued...\)](#)

[Lecture 34 - Micro Flow Sensor and Micro mixers](#)

[Lecture 35 - Micro mixers](#)

[Lecture 36 - Micro mixers \(Continued...\)](#)

[Lecture 37 - Micro droplets](#)

[Lecture 38 - Micro reactors \(Continued...\)](#)

[Lecture 39 - Micro needles and Microparticle separation](#)

[Lecture 40 - Few applications of microfluidics](#)

[Lecture 41 - Lab Demo](#)

- Lecture 1 - Introduction to convective heat transfer - Part 1
- Lecture 2 - Introduction to convective heat transfer - Part 2
- Lecture 3 - Continuity Equation
- Lecture 4 - Momentum and Energy Equations
- Lecture 5 - Energy Equation
- Lecture 6 - Reynolds Transport Theorem
- Lecture 7 - Entropy Generation and streamfunction-vorticity formulation
- Lecture 8 - Couette flow - Part 1
- Lecture 9 - Couette flow - Part 2
- Lecture 10 - Couette flow - Part 3
- Lecture 11 - Boundary layer approximation
- Lecture 12 - Laminar External flow past flat plate (Blasius Similarity Solution)
- Lecture 13 - Numerical solution to the Blasius equation and similarity solution to heat transfer
- Lecture 14 - Pohlhausen similarity solution and flows including pressure gradient (Falkner-Skan)
- Lecture 15 - Falkner skan solutions for heat transfer
- Lecture 16 - Similarity solution for flow and heat transfer with transpiration at walls
- Lecture 17 - Thermal boundary layer in high speed flows
- Lecture 18 - Approximate(Integral) methods for laminar external flow and heat transfer
- Lecture 19 - Integral method for laminar external thermal boundary layer over isothermal surface
- Lecture 20 - Integral method for flows with pressure gradient (von Karman-Pohlhausen method)
- Lecture 21 - Integral method with pressure gradient: heat transfer
- Lecture 22 - Heat transfer across a circular cylinder: Walz approximation
- Lecture 23 - Duhamel's method for varying surface temperature
- Lecture 24 - Laminar External heat transfer with non uniform surface temperature
- Lecture 25 - Laminar internal forced convection - fundamentals
- Lecture 26 - Hydrodynamically and thermally fully developed internal laminar flows
- Lecture 27 - Fully developed laminar internal flow and heat transfer
- Lecture 28 - Shooting method for fully developed heat transfer and thermal entry length problem
- Lecture 29 - Thermal entry length problem with plug velocity profile: Graetz problem
- Lecture 30 - Extended Graetz problem for parabolic velocity profile
- Lecture 31 - Extended Graetz problem

[Lecture 32 - Extended Graetz problem with wall flux boundary condition](#)

[Lecture 33 - Approximate method for laminar internal flows](#)

[Lecture 34 - Integral method for thermal entry length problem](#)

[Lecture 35 - Introduction to Natural Convection Heat Transfer](#)

[Lecture 36 - Similarity Solution in Natural Convection for Vertical isothermal Plate - Part 1](#)

[Lecture 37 - Similarity Solution in Natural Convection for Vertical isothermal Plate - Part 2](#)

[Lecture 38 - Similarity Solution in Natural Convection for Vertical isoflux Plate](#)

[Lecture 39 - Approximate Method in Natural Convection Heat Transfer](#)

[Lecture 40 - Natural Convection in Other Configurations](#)

[Lecture 41 - Turbulent Convective Heat Transfer : RANS Equations - Part 1](#)

[Lecture 42 - Turbulent Convective Heat Transfer : RANS Equations - Part 2](#)

[Lecture 43 - Analogies in Turbulent Convective Heat Transfer - Part 1](#)

[Lecture 44 - Analogies in Turbulent Convective Heat Transfer - Part 2](#)



Lecture 1 - Loud Bang and Disruption

Lecture 2 - Blast Wave in an Explosion: Predictions from Dimensional Considerations

Lecture 3 - Typical Examples of Explosions and Classification

Lecture 4 - Shock Hugoniot and Rayleigh Line

Lecture 5 - Properties behind a Constant Velocity Shock

Lecture 6 - Blast waves: Concentration of Mass at the Front, Snow Plow Approximation, Energy conservation in a Blast wave

Lecture 7 - Blast waves: Decay of a strong Blast wave, Explosion Length, Sach's Scaling, Over pressure, Cranz Hopkinson Scaling law of Overpressure

Lecture 8 - Blast Waves: Overpressure and Impulse in the Near and Far Field, Examples, Introduction to Impulse

Lecture 9 - Blast Waves: Non-dimensional Impulse, Cranz -Hopkinson Scaling, Missiles, Fragments and Shrapnel, Craters, Examples

Lecture 10 - Blast Waves: Interaction with Objects, Reflection and Transmission of Blast Waves, Impedance

Lecture 11 - Blast Waves: Amplification of Reflected Blast Waves; Role of Impedance, Spalling, Damage to Organs containing Air, Mushroom Cloud in an Explosion, Examples

Lecture 12 - Blast Waves: Damage from Blast Waves, Examples, Multiple Spikes in an Impulse, Iso-damage Curve on an Overpressure-Impulse Diagram, Complex Structures

Lecture 13 - Energy Release in a Chemical Reaction: Moles, Internal Chemical Energy, Standard Heats of Formation

Lecture 14 - Energy Release: Stoichiometry, Equivalence Ratio and Heat Release in Fuel Rich and Oxidizer Rich Compounds

Lecture 15 - Energy Release: Examples of Energy Release Calculations, Higher and Lower Calorific Values, Internal Energy of Formation

Lecture 16 - Rate of Energy Release: Concentration, Activation Energy, Energy Release Profile

Lecture 17 - Thermal Theory of Explosion

Lecture 18 - Thermal Theory

Lecture 19 - Role of Chain Carriers in an Explosion

Lecture 20 - Combustion - I

Lecture 21 - Combustion - II

Lecture 22 - Case Histories of Explosions involving Volatile Liquids

Lecture 23 - Detonation

Lecture 24 - Structure of Detonations

Lecture 25 - Realizable States in a Detonation

Lecture 26 - One Dimensional Model of Detonation

Lecture 27 - Case Histories of Explosions involving Detonation or Quasi-Detonation

Lecture 28 - Explosions in Confined and Unconfined Geometries

Lecture 29 - Dust Explosions - I

[Lecture 30 - Dust Explosions - II](#)

[Lecture 31 - Physical Explosions](#)

[Lecture 32 - Rupture of Cryogenic Storage Vessels and Pressure Vessels](#)

[Lecture 33 - Condensed Phased Explosives Based on Hydrocarbons](#)

[Lecture 34 - Condensed Phase Explosives and their Properties](#)

[Lecture 35 - TNT Equivalence and Yield of an Explosion](#)

[Lecture 36 - Atmospheric Dispersion](#)

[Lecture 37 - Modeling Atmospheric Dispersion](#)

[Lecture 38 - Explosions Involving Atmospheric Dispersion](#)

[Lecture 39 - Quantification of Damages in an Explosion](#)

[Lecture 40 - Risk Analysis for an Explosion](#)

- Lecture 1 - Introduction to Metrology
- Lecture 2 - Metrology terminologies
- Lecture 3 - Measurement errors
- Lecture 4 - Linear measuring instruments  $\hat{A}$ - 1 (Angle plate, steel rule, spring calipers)
- Lecture 5 - Linear measuring instruments  $\hat{A}$ - 2 (Combination set, Vernier calipers)
- Lecture 6 - Linear measuring instruments  $\hat{A}$ - 3 (Height gauge, Micrometers  $\hat{A}$ - 1)
- Lecture 7 - Linear measuring instruments  $\hat{A}$ - 4 (Micrometers  $\hat{A}$ - 2, Bore gauge)
- Lecture 8 - Linear measuring instruments  $\hat{A}$ - 5 (Dial indicators, thickness gauges, depth gauges)
- Lecture 9 - Manufacturing tolerances and fits
- Lecture 10 - Terminologies of limits fits and tolerances
- Lecture 11 - Numerical problems on fit and tolerances
- Lecture 12 - Selection of fits, Geometrical tolerances
- Lecture 13 - Positional tolerances
- Lecture 14 - Limit gauging - 1
- Lecture 15 - Limit gauging - 2
- Lecture 16 - Design of limit gauges
- Lecture 17 - Measurement of straightness, flatness and squareness
- Lecture 18 - Perpendicularity measurement
- Lecture 19 - Basics of surface roughness
- Lecture 20 - Surface finish parameters
- Lecture 21 - Stylus type surface finish measuring instruments
- Lecture 22 - Non-contact type surface finish measuring instruments
- Lecture 23 - Screw thread production and terminology
- Lecture 24 - Measurement of screw thread elements
- Lecture 25 - Introduction to gears
- Lecture 26 - Measurement of gear elements
- Lecture 27 - Angle measurement - 1
- Lecture 28 - Angle measurement - 2
- Lecture 29 - Radius measurement, Contact angle measurement
- Lecture 30 - Basics of interferometry
- Lecture 31 - Interferometers

[Lecture 32 - Introduction to comparators, Mechanical comparators](#)

[Lecture 33 - Electrical and electronic comparators, Optical comparators](#)

[Lecture 34 - Pneumatic comparators](#)

[Lecture 35 - Geometrical tests on lathe](#)

[Lecture 36 - Geometrical tests on pillar type drilling machine](#)

[Lecture 37 - Universal measuring machine \(UMM\) and Coordinate measuring machine \(CMM\)](#)

[Lecture 38 - CMM probes and CMM software](#)

[Lecture 39 - Feature measurement using CMM, Laser vision](#)

[Lecture 40 - In-process gauging and control](#)

[Lecture 41 - Stage position metrology](#)

[Lecture 42 - Micro and Nano stages, Nano technology instrumentation](#)

[Lecture 43 - Optical system design](#)

[Lecture 44 - Complex opto- mechanical assemblies, Metrology testing and certification services](#)

- Lecture 1 - Introduction to the course
- Lecture 2 - Newton's laws
- Lecture 3 - Equilibrium
- Lecture 4 - Example 1 - Statics
- Lecture 5 - Example 2 - Rigid Body Systems
- Lecture 6 - Example 3 - Rigid Body Systems
- Lecture 7 - Structural Systems with rigid bodies
- Lecture 8 - Types of 1-D Structural Elements
- Lecture 9 - Axial members
- Lecture 10 - Analysis of the truss system
- Lecture 11 - Stability of Structural systems
- Lecture 12 - Beams - Example 1
- Lecture 13 - Beams - BMD and SFD
- Lecture 14 - Beams - Loading, Shear and Bending Moment Relations
- Lecture 15 - Static Friction
- Lecture 16 - Friction - Solving Problems
- Lecture 17 - Particle Kinematics - 1
- Lecture 18 - Particle Kinematics - 2 (Example)
- Lecture 19 - Particle Kinematics - Curvilinear Coordinates
- Lecture 20 - Rigid Body Kinematics
- Lecture 21 - Rotational Motion (Example 1)
- Lecture 22 - Rotational Motion (Example 2)
- Lecture 23 - Dynamics (Introduction)
- Lecture 24 - Dynamics - Example 1
- Lecture 25 - Dynamics - Example 2
- Lecture 26 - Dynamics - Example 3
- Lecture 27 - Dynamics - Example 4
- Lecture 28 - Center of Percussion - Example
- Lecture 29 - Impulse / Momentum - Example 1
- Lecture 30 - Impulse / Momentum - Example 2
- Lecture 31 - Impulse / Momentum - Example 3

[Lecture 32 - Impulse / Momentum - Example 4](#)

[Lecture 33 - Work Energy Methods - Example 1](#)

[Lecture 34 - Work Energy Methods - Example 2](#)

[Lecture 35 - Work Energy Methods - Example 3](#)

[Week 1 - Module-1](#)

[Week 1 - Module-2](#)

[Week 1 - Module-3](#)

[Week 1 - Module-4](#)

[Week 1 - Module-5](#)

[Week 2 - Module-1](#)

[Week 2 - Module-2](#)

[Week 2 - Module-3](#)

[Week 2 - Module-4](#)

[Week 2 - Module-5](#)

[Week 3 - Module-1](#)

[Week 3 - Module-2](#)

[Week 3 - Module-3](#)

[Week 3 - Module-4](#)

[Week 3 - Module-5](#)

[Week 4 - Module-1](#)

[Week 4 - Module-2](#)

[Week 4 - Module-3](#)

[Week 4 - Module-4](#)

[Week 4 - Module-5](#)

[Week 5 - Module-1](#)

[Week 5 - Module-2](#)

[Week 5 - Module-3](#)

[Week 5 - Module-4](#)

[Week 5 - Module-5](#)

[Week 5 - Module-6](#)

[Week 6 - Module-1](#)

[Week 6 - Module-2 - Part 1](#)

[Week 6 - Module-2 - Part 2](#)

[Week 6 - Module-3](#)

[Week 6 - Module-4](#)

[Week 6 - Module-5](#)

[Week 7 - Module-1](#)

[Week 7 - Module-2](#)

[Week 7 - Module-3](#)

[Week 7 - Module-4](#)

[Week 7 - Module-5](#)

[Week 8 - Module-1](#)

[Week 8 - Module-2](#)

[Week 8 - Module-3](#)

[Week 8 - Module-4](#)

[Week 8 - Module-5](#)

[Week 8 - Module-6](#)

[Conclusion](#)



- Lecture 1 - Review of fundamentals of fluid mechanics - I
- Lecture 2 - Review of fundamentals of fluid mechanics - II
- Lecture 3 - Concept of a Boundary Layer (BL) - I
- Lecture 4 - Concept of a Boundary Layer (BL) - II
- Lecture 5 - Concepts of BL thickness (?)
- Lecture 6 - Concepts of BL displacement thickness ( $\delta^*$ ) and BL momentum thickness ( $\theta$ )
- Lecture 7 - Control Volume approach to derive expressions for  $\delta^*$  over a flat plate
- Lecture 8 - Control Volume approach to derive expressions for  $\theta$  over a flat plate
- Lecture 9 - Concept of wall friction
- Lecture 10 - Concept of friction drag
- Lecture 11 - Skin Friction Coefficient - I
- Lecture 12 - Skin Friction Coefficient - II
- Lecture 13 - Derivation of Prandtl's Laminar BL Equations - I
- Lecture 14 - Derivation of Prandtl's Laminar BL Equations - II
- Lecture 15 - Derivation of Prandtl's Laminar BL Equations - III
- Lecture 16 - Derivation of Prandtl's Laminar BL Equations - IV
- Lecture 17 - Similarity Solutions to the BL Equations Applied to a Flat Plate - I
- Lecture 18 - Similarity Solutions to the BL Equations Applied to a Flat Plate - II
- Lecture 19 - Similarity Solutions to the BL Equations Applied to a Flat Plate - III
- Lecture 20 - Runge-Kutta Method to Numerically Solve the BL Equations Applied to a Flat Plate
- Lecture 21 - Description of the Numerical Code to Solve the BL Equations Applied to a Flat Plate
- Lecture 22 - Similarity Solutions to the BL Equations (other than flat plate) - I
- Lecture 23 - Similarity Solutions to the BL Equations (other than flat plate) - II
- Lecture 24 - Similarity Solutions to the BL Equations (other than flat plate) - III
- Lecture 25 - Similarity Solutions to the BL Equations (other than flat plate) - IV
- Lecture 26 - Description of the Numerical Code to Solve the BL Equations (other than flat plate)
- Lecture 27 - The Energy Equation - I
- Lecture 28 - The Energy Equation - II
- Lecture 29 - Similarity Solutions to Thermal BL - I
- Lecture 30 - Similarity Solutions to Thermal BL - II
- Lecture 31 - Similarity Solutions to Thermal BL - III

[Lecture 32 - BL Separation with Pressure-Gradient - I](#)

[Lecture 33 - BL Separation with Pressure Gradient - II](#)

[Lecture 34 - Effect of Prandtl Number in Thermal BL - I](#)

[Lecture 35 - Effect of Prandtl Number in Thermal BL - II](#)

[Lecture 36 - Effect of Prandtl Number in Thermal BL - III](#)

[Lecture 37 - Effect of Dissipation in Thermal BL - I](#)

[Lecture 38 - Effect of Dissipation in Thermal BL - II](#)

[Lecture 39 - Effect of Dissipation in Thermal BL - III](#)

[Lecture 40 - Similarity Solutions to Thermal BL - An Overview](#)

Lecture 1 - Introduction

Lecture 2 - Basics of Thermodynamics

Lecture 3 - Tutorial 1

Lecture 4 - Control Volume Approach

Lecture 5 - Conservation Equations

Lecture 6 - Tutorial 2

Lecture 7 - Energy Equation

Lecture 8 - Concept of stagnation

Lecture 9 - Discussion on stagnation

Lecture 10 - Velocity of sound

Lecture 11 - Discussion on velocity of sound and mach number

Lecture 12 - Wave propagation

Lecture 13 - Mach wave

Lecture 14 - Mach number relations

Lecture 15 - Variable Area Adiabatic flow

Lecture 16 - Variable Area Adiabatic flow (Continued...)

Lecture 17 - \* reference quantities and their relations

Lecture 18 - Importance of stagnation temperature in relation to v

Lecture 19 - Discussion on variable area adiabatic flow and \* reference quantities

Lecture 20 - Gas tables

Lecture 21 - Converging nozzle

Lecture 22 - Condition of choked flow and associated properties

Lecture 23 - Area ratio and pressure ratio in converging nozzles

Lecture 24 - Discussion on converging nozzles

Lecture 25 - Converging - Diverging (C-D) nozzles

Lecture 26 - More on C-D nozzles

Lecture 27 - Discussion on C-D nozzles - 1

Lecture 28 - Discussion on C-D nozzles - 2

Lecture 29 - Examples and applications of flow through C-D nozzles

Lecture 30 - Introduction to normal shocks

Lecture 31 - Normal shock relations - 1

[Lecture 32 - Normal shock relations - 2](#)

[Lecture 33 - Rankine-Hugoniot equation](#)

[Lecture 34 - Discussion on Normal Shocks - 1](#)

[Lecture 35 - Discussion on Normal Shocks - 2](#)

[Lecture 36 - Normal shocks in C-D nozzles](#)

[Lecture 37 - Normal shocks in C-D nozzles \(Continued...\)](#)

[Lecture 38 - Moving Normal Shocks](#)

[Lecture 39 - Discussion on moving normal shocks](#)

[Lecture 40 - Oblique shocks](#)

[Lecture 41 - Oblique shock relations](#)

[Lecture 42 - Discussion on oblique shocks](#)

[Lecture 43 - Reflection of oblique shocks](#)

[Lecture 44 - Discussion on reflection of oblique shocks](#)

[Lecture 45 - Prandtl-Meyer flow](#)

[Lecture 46 - Prandtl-Meyer flow \(Continued...\)](#)

[Lecture 47 - Discussion on Prandtl-Meyer expansion](#)

[Lecture 48 - Shock Polar diagram and Prandtl-Meyer relation for Oblique shocks](#)

Lecture 1 - Introduction to Stress Analysis – Analytical and Numerical Approaches

Lecture 2 - Introduction to Stress Analysis - Experimental Approaches

Lecture 3 - Optical Methods Work as Optical Computers

Lecture 4 - Basic information provided by various experimental methods

Lecture 5 - Visual Appreciation of Field Information - Part 1

Lecture 6 - Visual Appreciation of Field Information - Part 2

Lecture 7 - Visual Appreciation of Field Information - Part 3

Lecture 8 - Visual Appreciation of Field Information - Part 4

Lecture 9 - Visual Appreciation of Field Information - Part 5

Lecture 10 - Completeness of a Numerical Solution

Lecture 11 - Principle of Strain Gauges

Lecture 12 - Overview of Strain Gauge Measurements

Lecture 13 - Elegance of Photoelasticity

Lecture 14 - Introduction to Photoelasticity

Lecture 15 - Different Polariscope

Lecture 16 - Principles of Moiré

Lecture 17 - Introduction to Moiré

Lecture 18 - Introduction to Brittle Coatings

Lecture 19 - Introduction to Holography

Lecture 20 - Introduction to Hologram Interferometry

Lecture 21 - Introduction to Double exposure hologram interferometry

Lecture 22 - Introduction to Speckle Methods

Lecture 23 - Introduction to Speckle Interferometry Techniques

Lecture 24 - Introduction to TSA and DIC

Lecture 25 - Introduction to Caustics

Lecture 26 - Introduction to Coherent Gradient Sensor

Lecture 27 - Naming of Experimental Methods

Lecture 28 - Fringe Patterns - Richness of Qualitative Information

Lecture 29 - Key technologies that have influenced Experimental Mechanics

Lecture 30 - Multiscale analysis and trends in experimental mechanics

Lecture 31 - Selection of an experimental technique - Part 1



Lecture 1 - Introduction to Fluid Flow

Lecture 2 - Flow field, Stresses on fluid element, Newtonian fluid

Lecture 3 - Non Newtonian fluid, Classification of flow, Analysis of flow

Lecture 4 - Tutorial

Lecture 5 - Lecture 1 - Integral analysis, Control volume, Generalised conservation equation

Lecture 6 - Lecture 2 - Mass and linear momentum conservation in CV

Lecture 7 - Lecture 3 - Angular momentum conservation, Non-inertial frame of reference

Lecture 8 - Lecture 4 - Tutorial

Lecture 9 - Lecture 1 - Differential Analysis

Lecture 10 - Lecture 2 - Navier-Stokes equation for 2D incompressible flow

Lecture 11 - Lecture 3 - Vorticity, Stream function, Bernoulli's equation

Lecture 12 - Lecture 4 - Tutorial

Lecture 13 - Lecture 1 - External flows, Laminar and Turbulent Boundary Layer

Lecture 14 - Lecture 2 - Differential analysis of boundary layer, Blassius equation

Lecture 15 - Lecture 3 - Boundary Layer flow with pressure gradient, Flow separation

Lecture 16 - Lecture 4 - Internal flow, Pipe friction

Lecture 17 - Lecture 1 - Basic Thermodynamics

Lecture 18 - Lecture 2 - Turbomachines: Definition and classification

Lecture 19 - Lecture 3 - Dimensional Analysis

Lecture 20 - Lecture 4 - Tutorial

Lecture 21 - Lecture 1 - Representation of Turbomachines and Definition of velocity

Lecture 22 - Lecture 2 - Euler's energy equation

Lecture 23 - Lecture 3 - Real fluid flow and efficiency of turbomachine

Lecture 24 - Lecture 4 - Tutorial

Lecture 25 - Lecture 1 - Pumps

Lecture 26 - Lecture 2 - Pumping Systems

Lecture 27 - Lecture 3 - Hydraulic Turbines : Pelton Turbine

Lecture 28 - Lecture 4 - Hydraulic Turbines : Reaction Turbines

Lecture 29 - Lecture 5 - Cavitation in Hydroturbomachines

Lecture 30 - Lecture 6 - Tutorial

Lecture 31 - Lecture 1 - Introduction to compressible flow

[Lecture 32 - Lecture 2 - Steam and Gas Turbine : Introduction and classification](#)

[Lecture 33 - Lecture 3 - Steam and Gas Turbine : h-s Plots and velocity triangle](#)

[Lecture 34 - Lecture 4 - Tutorial](#)



Lecture 1 - Overview to Micro/Nanoscale energy transport - Part 1

Lecture 2 - Overview to Micro/Nanoscale energy transport - Part 2

Lecture 3 - Some applications of Micro/Nanoscale energy transport

Lecture 4 - Continuum heat transfer and its limitation

Lecture 5 - Energy carriers at Micro/Nanoscale and their attributes

Lecture 6 - Microscopic contributes to Internal energy of a systems

Lecture 7 - Fundamentals of Quantum mechanics - Part 1

Lecture 8 - Fundamentals of Quantum mechanics - Part 2

Lecture 9 - Fundamentals of Quantum mechanics - Part 3

Lecture 10 - Fundamentals of Quantum mechanics - Part 4

Lecture 11 - Fundamentals of Quantum mechanics - Part 5

Lecture 12 - Fundamentals of solid state physics - Part 1

Lecture 13 - Fundamentals of solid state physics - Part 2

Lecture 14 - Fundamentals of solid state physics - Part 3

Lecture 15 - Fundamentals of solid state physics - Part 4

Lecture 16 - Fundamentals of statistical thermodynamics - Part 1

Lecture 17 - Fundamentals of statistical thermodynamics - Part 2

Lecture 18 - Fundamentals of statistical thermodynamics - Part 3

Lecture 19 - Fundamentals of statistical thermodynamics - Part 4

Lecture 20 - Kinetic theory of energy carriers - Part 1

Lecture 21 - Kinetic theory of energy carriers - Part 2

Lecture 22 - Non-equilibrium energy transport at Nanoscales: Boltzmann Transport Equation (BTE)

Lecture 23 - Boltzmann Transport Equation under the relaxation time approximation

Lecture 24 - Derivation of Continuum laws from Boltzmann Transport Equation - Part 1

Lecture 25 - Derivation of Continuum laws from Boltzmann Transport Equation - Part 2

Lecture 26 - Derivation of Continuum laws from Boltzmann Transport Equation - Part 3

Lecture 27 - Nanoscale Energy transport in a Thin Film - Part 1

Lecture 28 - Nanoscale Energy transport in a Thin Film - Part 2

Lecture 29 - Nanoscale Energy transport in a Thin Film - Part 3

Lecture 30 - Gas flow and Heat transport in Microchannels - Part 1

Lecture 31 - Gas flow and Heat transport in Microchannels - Part 2

[Lecture 32 - Single phase liquid flow and Heat transport in Microchannels - Part 1](#)

[Lecture 33 - Single phase liquid flow and Heat transport in Microchannels - Part 2](#)

[Lecture 34 - Fundamentals of Electro kinetics in Microchannels Part1](#)

[Lecture 35 - Fundamentals of Electro kinetics in Microchannels Part2](#)

[Lecture 36 - Fundamentals of Electro kinetics in Microchannels Part3](#)

[Lecture 37 - Two phase Heat transfer in Microchannels - Part 1](#)

[Lecture 38 - Two phase Heat transfer in Microchannels - Part 2](#)

[Lecture 39 - Nano fluid Heat transfer - Part 1](#)

[Lecture 40 - Nano fluid Heat transfer - Part 2](#)

[Lecture 41 - Measurement techniques in Micro and Nanoscale Heat transfer - Part 1](#)

[Lecture 42 - Measurement techniques in Micro and Nanoscale Heat transfer - Part 2](#)

- Lecture 1 - 1D-2D-3D lattice
- Lecture 2 - Stereographic projection - 1
- Lecture 3 - Stereographic Projection - 2
- Lecture 4 - Symmetry in 1-D crystals
- Lecture 5 - Symmetry in 2-D crystals
- Lecture 6 - Symmetry in 3-D crystals
- Lecture 7 - Understanding IUCr tables
- Lecture 8 - Symmetry in 3-D Crystals
- Lecture 9 - Reciprocal lattice
- Lecture 10 - Directions Planes and zone axes
- Lecture 11 - Interplanar distances and angles
- Lecture 12 - Diffraction - 1
- Lecture 13 - Diffraction - 2
- Lecture 14 - Diffraction - Structure and Shape Factor
- Lecture 15 - Transformation of Indices
- Lecture 16 - Microscope - 1
- Lecture 17 - Microscope - 2
- Lecture 18 - Kikuchi Diffraction
- Lecture 19 - Double Diffraction and CBED
- Lecture 20 - CBED and Precession Electron Diffraction
- Lecture 21 - Indexing Diffraction Pattern
- Lecture 22 - Correlation of Diffraction Spots to Microstructure
- Lecture 23 - 3-Index to 4-Index System
- Lecture 24 - Kinematical and Dynamical Theory of Diffraction and Imaging
- Lecture 25 - Contrast from Planar Defects
- Lecture 26 - Contrast from Strain Fields
- Lecture 27 - Atomic Scattering Factor
- Lecture 28 - Coherence
- Lecture 29 - Lens Aberrations
- Lecture 30 - Phase Contrast Microscopy - 1
- Lecture 31 - Phase Contrast Microscopy - 2

[Lecture 32 - Phase Contrast Microscopy - 3](#)

[Lecture 33 - STEM](#)

[Lecture 34 - ELES and EDS](#)

[Lecture 35 - Recent trends](#)

[Lecture 36 - Energy dispersive Spectroscopy](#)

[Lecture 37 - Revision - 1](#)

[Lecture 38 - Revision - 2](#)

[Lecture 39 - Revision of Recent trends in Microscopy](#)

[Lecture 40 - Crystallography Revision](#)

Lecture 1 - Module 1 - Introduction - 1

Lecture 2 - Module 1 - Introduction - 2

Lecture 3 - Module 2 - Governing Equation - 1

Lecture 4 - Module 2 - Governing Equation - 2

Lecture 5 - Module 3 - Plane Wave - 1

Lecture 6 - Module 3 - Plane Wave - 2

Lecture 7 - Module 4 - Reflection Of Plane Waves - 1

Lecture 8 - Module 4 - Reflection Of Plane Waves - 2

Lecture 9 - Module 5 - Frequency Analysis - 1

Lecture 10 - Module 5 - Frequency Analysis - 2

Lecture 11 - Module 6 - Harmonic Plane Waves

Lecture 12 - Module 7 - Travelling And Standing Waves

Lecture 13 - Module 8 - Acoustic Mode Shapes, Reflection

Lecture 14 - Module 9 - Plane Waves : Reflection and Intermission

Lecture 15 - Module 10 - Flexural Waves, evanescent Waves

Lecture 16 - Module 11 - Near Field Acoustic Waves

Lecture 17 - Module 12 - cuton Waves in duct

Lecture 18 - Module 13 - Power Calculation

Lecture 19 - Module 14 - Decibel Scale

Lecture 20 - Module 15 - Db Arithmetic

Lecture 21 - Module 16 - Sound Power Level

Lecture 22 - Module 17 - Human factors in Acoustic Engineering

Lecture 23 - Module 18 - Microphone

Lecture 24 - Module 19 - Acoustic Measurements

Lecture 25 - Module 20 - Muffler Analysis

Lecture 26 - Module 21 - Transfer Matrix Method

Lecture 27 - Module 22 - Electro Mechanical Analogies - Part 1

Lecture 28 - Module 23 - Electro Mechanical Analogies Simple Example

Lecture 29 - Module 24 - Electro Mechanical Analogies Example

Lecture 30 - Module 25 - Helmholtz Resonator

Lecture 31 - Module 26 - Source Impedance

[Lecture 32 - Module 27 - Insertion Loss](#)

[Lecture 33 - Module 28 - Analysis Of Industrial Mufflers](#)

[Lecture 34 - Module 29 - Spherical Waves](#)

[Lecture 35 - Module 30 - Monopole and Dipole](#)

[Lecture 36 - Module 31 - Inhomogeneous Wave Equation](#)

[Lecture 37 - Module 32 - Green's Function](#)

[Lecture 38 - Module 33 - Kirchoff Helmholtz Integral Equation](#)

[Lecture 39 - Tutorial 1](#)

[Lecture 40 - Tutorial 2](#)

[Lecture 41 - Tutorial 3](#)

[Lecture 42 - Tutorial 4](#)

Lecture 1 - Concept of Steel Quality

Lecture 2 - Control of Residuals and Impact on Quality

Lecture 3 - Non-Metallic Inclusions

Lecture 4 - Evaluation of Residuals and Inclusions

Lecture 5 - Cleanliness Requirements for Different applications

Lecture 6 - Limitation of Primary Steelmaking and Importance of secondary Refining

Lecture 7 - Deoxidation

Lecture 8 - Prevention of Slag carryover

Lecture 9 - Desulphurisation

Lecture 10 - Degassing

Lecture 11 - Secondary Refining Processes

Lecture 12 - Injection of Calcium

Lecture 13 - Different Routes and Temperature Control

Lecture 14 - Decarburisation

Lecture 15 - Cleanliness Measures in Ladle and Tundish

Lecture 16 - Cleanliness Measures in Mould

Lecture 17 - Nature and Distribution of Entrapments in Casting

Lecture 18 - Genesis of Entrapment

Lecture 19 - Effect of Vertical vis-a-vis Curved Mould

Lecture 20 - Quality of Cast Product

Lecture 21 - Role of Concast Process, Caster Design and Steel Grade

Lecture 22 - Primary Cooling in Caster Mould

Lecture 23 - Heat Transfer in Mould

Lecture 24 - Role of Mould Oscillation

Lecture 25 - Cast Structure and Dendrite Size

Lecture 26 - Role of Chemistry - Part I

Lecture 27 - Role of Chemistry - Part II

Lecture 28 - Role of Segregation - Part I

Lecture 29 - Role of Segregation - Part II

Lecture 30 - Deleterious Effect of Phosphorus

Lecture 31 - Strength of Solidifying Strand

[Lecture 32 - Brittle Zone Near Solidus](#)

[Lecture 33 - Strength and Toughness of Solid Shell](#)

[Lecture 34 - Role of Chemistry on Solidification Behaviour](#)

[Lecture 35 - Sticking vis-a-vis Depression Behaviour](#)

[Lecture 36 - Role of Chemistry on Bulging or Depression Tendency - Part I](#)

[Lecture 37 - Role of Chemistry on Bulging or Depression Tendency - Part II](#)

[Lecture 38 - Effect of Cast Grain Size](#)

[Lecture 39 - Brittle Temperature Regions](#)

[Lecture 40 - Typical Cracks and Defects - Part I](#)

[Lecture 41 - Typical Cracks and Defects - Part II](#)

[Lecture 42 - Remedial Measures to Control Defects - Part I](#)

[Lecture 43 - Remedial Measures to Control Defects - Part II](#)

[Lecture 44 - Remedial Measures to Control Defects - Part III](#)

[Lecture 45 - Grade - Specific Casting Parameters - Part I](#)

[Lecture 46 - Grade - Specific Casting Parameters - Part II](#)

[Lecture 47 - Identification of Genesis of Quality Problems Through Metallographic Investigation - Part I](#)

[Lecture 48 - Identification of Genesis of Quality Problems Through Metallographic Investigation - Part II](#)

[Lecture 49 - Identification of Genesis of Quality Problems Through Metallographic Investigation - Part III](#)



Lecture 1 - Geometry of Crystals

Lecture 2 - Geometry of Crystals (Continued...)

Lecture 3 - Tutorial-1

Lecture 4 - Reciprocal Lattice

Lecture 5 - Stereographic Projection

Lecture 6 - Tutorial-2

Lecture 7 - Point Groups and Space Groups

Lecture 8 - Point Groups and Space Groups (Continued...)

Lecture 9 - Tutorial-3

Lecture 10 - Point Groups and Space Groups (Continued...)

Lecture 11 - Basics of X-Rays

Lecture 12 - Production and Detection of X-Rays

Lecture 13 - Production and Detection of X-Rays (Continued...)

Lecture 14 - Principles of X-Ray Diffraction

Lecture 15 - X-Ray Diffraction Methods

Lecture 16 - Debye Sherrer Camera

Lecture 17 - Diffractometer Measurements

Lecture 18 - Tutorial-4

Lecture 19 - Intensity of Diffracted Beams

Lecture 20 - Intensity of Diffracted Beams (Continued...)

Lecture 21 - Determination of Crystal Structures

Lecture 22 - Precise Lattice Parameter Determination

Lecture 23 - XRD - Lab Demonstration

Lecture 24 - Discussion - Based on Forum Queries - 1

Lecture 25 - Phase Diagram Determination

Lecture 26 - Ordered Disordered Transformation

Lecture 27 - Ordered Disordered Transformation (Continued...)

Lecture 28 - Qualitative Phase Analysis

Lecture 29 - Quantitative Phase Analysis - 1

Lecture 30 - Precise Lattice Parameter Determination - 1

Lecture 31 - Chemical Analysis by X-Ray Fluorescence

[Lecture 32 - Chemical Analysis by X-Ray Absorption](#)

[Lecture 33 - Effect of Crystallite Size on Diffracted X-Ray Intensity](#)

[Lecture 34 - Texture Determination by XRD](#)

[Lecture 35 - Particle Size Determination by XRD](#)

[Lecture 36 - Effect of Crystallite Size on Diffracted X-Ray Intensity](#)

[Lecture 37 - Determination of Single Crystal Orientation by X-Rays](#)

[Lecture 38 - Stress Analysis by X-Rays](#)

[Lecture 39 - Factors Contributing to Peak Broadening](#)

[Lecture 40 - Residual Stress Measurement by X-Rays](#)

Lecture 1 - Subscript Notation - Part 1

Lecture 2 - Subscript Notation - Part 2

Lecture 3 - Coordinate Rotation

Lecture 4 - Introduction to Tensors

Lecture 5 - Symmetry of Properties

Lecture 6 - Material Derivative

Lecture 7 - Planar Flows

Lecture 8 - Reynolds Transport Theorem

Lecture 9 - Derivation of Navier-Stokes equation

Lecture 10 - Navier Stokes equations - Part 2

Lecture 11 - Flow problem statements

Lecture 12 - Simple cases in fluid flow : rectangular coordinate system

Lecture 13 - Simple cases in fluid flow : cylindrical coordinate system

Lecture 14 - Pipe flow and porous medium

Lecture 15 - Simple cases in fluid flow : spherical coordinate system

Lecture 16 - Friction factors and correlations

Lecture 17 - Energy Transport

Lecture 18 - Conduction cases - Steady state

Lecture 19 - Conduction cases - Transient state

Lecture 20 - Convective heat transfer

Lecture 21 - Mass Transfer Overview

Lecture 22 - Chemical Equilibrium

Lecture 23 - Reaction Equilibrium

Lecture 24 - Species Balance Equation

Lecture 25 - Solute Transfer Modelling - Part 1

Lecture 26 - Solute Transfer Modelling - Part 2

Lecture 27 - Solute Segregation Profile - Part 1

Lecture 28 - Solute Segregation Profile - Part 2

Lecture 29 - Problem Statements

Lecture 30 - Diffusion in Solid State

Lecture 31 - Transient Solute Diffusion in Solid State

[Lecture 32 - Mass Transfer in Fluids](#)

[Lecture 33 - Similarity Across Transport Phenomena](#)

Lecture 1 - Overview of Experimental Stress Analysis

Lecture 2 - Optical Methods Work as Optical Computers

Lecture 3 - Stress, Strain and Displacement Fields

Lecture 4 - Completeness of a numerical solution

Lecture 5 - Fringe Patterns - Richness of Qualitative Information

Lecture 6 - Multi-Scale Analysis in Experimental Mechanics

Lecture 7 - Selection of an Experimental Technique

Lecture 8 - Introduction to Transmission Photoelasticity

Lecture 9 - Ordinary and Extraordinary Rays

Lecture 10 - Light Ellipse, Passage of Light Through a Crystal Plate

Lecture 11 - Retardation Plates, Stress-optic Law

Lecture 12 - Plane Polariscopes

Lecture 13 - Jones Calculus

Lecture 14 - Circular Polariscopes

Lecture 15 - Determination of Photoelastic Parameters at an Arbitrary Point

Lecture 16 - Tardy's Method of Compensation

Lecture 17 - Calibration of Photoelastic Materials

Lecture 18 - Fringe Thinning Methodologies

Lecture 19 - Fringe Ordering in Photoelasticity

Lecture 20 - Miscellaneous Topics in Transmission Photoelasticity

Lecture 21 - Three Dimensional Photoelasticity

Lecture 22 - Overview of Digital Photoelasticity

Lecture 23 - Introduction to Photoelastic Coatings

Lecture 24 - Correction Factors for Photoelastic Coatings

Lecture 25 - Coating Materials, Selection of Coating Thickness, Industrial Application of Photoelastic Coatings

Lecture 26 - Calibration of Photoelastic Coatings, Introduction to Brittle Coatings

Lecture 27 - Analysis of Brittle Coatings

Lecture 28 - Introduction to Strain Gauges

Lecture 29 - Strain Sensitivity of a Strain Gauge, Bridge Sensitivity, Rosettes

Lecture 30 - Strain Gauge Alloys, Carriers and Adhesives

Lecture 31 - Performance of Strain Gauge System

[Lecture 32 - Temperature Compensation, Two-wire and Three-wire Circuits](#)

[Lecture 33 - Strain Gauge Selection](#)

[Lecture 34 - Bonding of a Strain Gauge](#)

[Lecture 35 - Soldering, Accounting for Transverse Sensitivity Effects](#)

[Lecture 36 - Correction Factors for Special Applications](#)

[Lecture 37 - Special Gauges](#)

Lecture 1 - Basic Terminologies

Lecture 2 - Skeletal System

Lecture 3 - Axial and Appendicular Skeleton

Lecture 4 - Bones in the Human Body

Lecture 5 - Types of Joints

Lecture 6 - Movements about Joints

Lecture 7 - Levers in the Human Body

Lecture 8 - Skeletal Muscles: Functions

Lecture 9 - Skeletal Muscles: Structure - Part I

Lecture 10 - Skeletal Muscles: Structure - Part II

Lecture 11 - Mechanics and Modeling of Muscles

Lecture 12 - Muscle Action - Part I

Lecture 13 - Muscle Action - Part II

Lecture 14 - Principles of Statics

Lecture 15 - Static Analysis of Elbow - Part I

Lecture 16 - Static Analysis of Elbow - Part II

Lecture 17 - Static Analysis of Shoulder - Part I

Lecture 18 - Static Analysis of Shoulder - Part II

Lecture 19 - Static Analysis of Spine - Part I

Lecture 20 - Static Analysis of Spine - Part II

Lecture 21 - Static Analysis of Spine - Part III

Lecture 22 - Static Analysis of Hip - Part I

Lecture 23 - Static Analysis of Hip - Part II

Lecture 24 - Static Analysis of the Knee

Lecture 25 - Static Analysis of the Knee and Ankle

Lecture 26 - Kinetics: Linear Motion - Part I

Lecture 27 - Kinetics: Linear Motion - Part II

Lecture 28 - Kinetics: Linear Motion - Part III

Lecture 29 - Kinetics: Angular Motion - Part I

Lecture 30 - Kinetics: Angular Motion - Part II

Lecture 31 - Kinetics: Angular Motion - Part III

- [Lecture 32 - Kinetics: Angular Motion - Part IV](#)
- [Lecture 33 - Kinetics of Arm Swinging during Walking](#)
- [Lecture 34 - Inverse Dynamics Analysis](#)
- [Lecture 35 - Biomechanics of Balance - Part I](#)
- [Lecture 36 - Biomechanics of Balance - Part II](#)
- [Lecture 37 - Biomechanics of Balance - Part III](#)
- [Lecture 38 - Human Gait](#)
- [Lecture 39 - Human Gait Terminologies](#)
- [Lecture 40 - Characteristics of Normal Gait - Part I](#)
- [Lecture 41 - Characteristics of Normal Gait - Part II](#)
- [Lecture 42 - Characteristics of Normal Gait - Part III](#)
- [Lecture 43 - Pathological Gait - Part I](#)
- [Lecture 44 - Pathological Gait - Part II](#)
- [Lecture 45 - Pathological Gait - Part III](#)
- [Lecture 46 - Introduction to Assistive Devices for Mobility](#)
- [Lecture 47 - Design Considerations: Prosthetic Foot](#)
- [Lecture 48 - Design Considerations: Prosthesis and Orthosis](#)
- [Lecture 49 - Design Considerations: Prosthetic Knee](#)
- [Lecture 50 - Journey of Standing Wheelchair Development](#)



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

**NPTEL : NOC:Design for Quality, Manufacturing and Assembly (Mechanical Engineering)**

**Co-ordinators : Prof. Palaniappaan Ramu**

Lecture 1 - Introduction to DfX

Lecture 2 - Introduction to Quality

Lecture 3 - Introduction to Robustness

Lecture 4 - Introduction to Six Sigma Concept

Lecture 5 - Recap and clarifications of basic concepts

Lecture 6 - Review of Six Sigma and Quality Loss Function (QLF)

Lecture 7 - Types of QLF and SN Ratio

Lecture 8 - Linking Quality and Robustness

Lecture 9 - Design for Six Sigma - Stages, Design of Experiments

Lecture 10 - Introduction To Design Of Experiments

Lecture 11 - Need for DoE and basic DoE methods

Lecture 12 - Factorial Design

Lecture 13 - Orthogonal Array- L4 and L8 example

Lecture 14 - Setting up an Orthogonal Array

Lecture 15 - Confounding OA and Resolution Table

Lecture 16 - Confounding Logic and Randomization of Experiments

Lecture 17 - Paper Helicopter Case Study - Part I

Lecture 18 - Paper Helicopter Case Study - Part II

Lecture 19 - Introduction To Injection Molding Process, Materials, Terminologies Related To Plastic Parts and Design Guidelines

Lecture 20 - Estimation of Mold Cost for Injection Molding (Dixon and Poli's Method)

Lecture 21 - Estimation of Mold Cost for Injection Molding (Dixon and Poli's Method) (Continued...)

Lecture 22 - Mold Cost Estimation - Tutorial

Lecture 23 - Design for Additive Manufacturing

Lecture 24 - Demo

Lecture 25 - Introduction to Sustainable Development and Sustainability Indicators - Part 1

Lecture 26 - Introduction to Sustainable Development and Sustainability Indicators - Part 2

Lecture 27 - Introduction to design process

Lecture 28 - Accounting for manufacturability and assembly in design - An overview

Lecture 29 - DfMA in product design

Lecture 30 - General design guidelines for manual assembly

Lecture 31 - Systematic DFA methodology

[Lecture 32 - Alpha symmetry, Beta symmetry](#)

[Lecture 33 - Quantification of part size and thickness](#)

[Lecture 34 - Systematic DFA Case study - controller assembly](#)

[Lecture 35 - DFA examples and discussion](#)

[Lecture 36 - Xerox Producibility Index \(XPI\)](#)

[Lecture 37 - High Speed and Robotic Assembly](#)

[Lecture 38 - Sheet Metal Working](#)

[Lecture 39 - Overview of DoE Workflow](#)

[Lecture 40 - DFA Software](#)

[Lecture 41 - DFM Software and Case Studies](#)

Lecture 1 - Overview and Motivation of Course

Lecture 2 - Basic Optimization Problem Formulation

Lecture 3 - Problem Formulation Example

Lecture 4 - Calculus related to Optimization

Lecture 5 - The big picture - Overview

Lecture 6 - Introduction to DOE - 1

Lecture 7 - Introduction to DOE - 2

Lecture 8 - Types of DOE - 1

Lecture 9 - Types of DOE - 2 and some examples

Lecture 10 - Introduction to surrogate modeling

Lecture 11 - Types of surrogate - Polynomial models

Lecture 12 - Radial basis function - 1

Lecture 13 - Radial basis function - 2

Lecture 14 - Kriging - 1

Lecture 15 - Kriging - 2

Lecture 16 - Metamodels for Safe and Efficient Automotive Structures

Lecture 17 - Exploration and Exploitation in Surrogates

Lecture 18 - Errors Based Exploration

Lecture 19 - Ensemble of Surrogates

- Lecture 1 - Concept of Steel Quality
- Lecture 2 - Typical Examples of Surface Defects
- Lecture 3 - Origin of Common Quality Problems
- Lecture 4 - Present Scenario on Quality Demands
- Lecture 5 - Control of Residuals and Impact on Quality
- Lecture 6 - Non-Metallic Inclusions
- Lecture 7 - Evaluation of Residuals and Inclusions
- Lecture 8 - Cleanliness Requirements for Different applications
- Lecture 9 - Limitation of Primary Steelmaking and Importance of secondary Refining
- Lecture 10 - Deoxidation
- Lecture 11 - Prevention of Slag carryover
- Lecture 12 - Desulphurisation
- Lecture 13 - Degassing
- Lecture 14 - Secondary Refining Processes
- Lecture 15 - Injection of Calcium
- Lecture 16 - Decarburisation
- Lecture 17 - Cleanliness Measures in Ladle and Tundish
- Lecture 18 - Cleanliness Measures in Mould
- Lecture 19 - Different Routes and Temperature Control
- Lecture 20 - Nature and Distribution of Entrapments in Casting
- Lecture 21 - Sources of Exogenous Entrapments
- Lecture 22 - Effect of Vertical vis-a-vis Curved Mould
- Lecture 23 - Quality of Cast Product
- Lecture 24 - Role of Concast Process, Caster Design and Steel Grade
- Lecture 25 - Primary Cooling in Caster Mould
- Lecture 26 - Heat Transfer in Mould
- Lecture 27 - Cast Structure and Dendrite Size
- Lecture 28 - Role of Mould Oscillation
- Lecture 29 - Role of Chemistry - Part I
- Lecture 30 - Role of Chemistry - Part II
- Lecture 31 - Role of Segregation - Part I

Lecture 32 - Role of Segregation - Part II

Lecture 33 - Deleterious Effect of Phosphorus

Lecture 34 - Strength of Solidifying Strand

Lecture 35 - Brittle Zone Near Solidus

Lecture 36 - Strength and Toughness of Solid Shell

Lecture 37 - Role of Chemistry on Solidification Behaviour

Lecture 38 - Sticking vis-a-vis Depression Behaviour

Lecture 39 - Role of Chemistry on Bulging or Depression Tendency - Part I

Lecture 40 - Role of Chemistry on Bulging or Depression Tendency - Part II

Lecture 41 - Effect of Cast Grain Size

Lecture 42 - Brittle Temperature Regions

Lecture 43 - Role of Secondary Cooling - Part 1

Lecture 44 - Role of Secondary Cooling - Part 2

Lecture 45 - Typical Cracks and Defects - Part I

Lecture 46 - Typical Cracks and Defects - Part II

Lecture 47 - Remedial Measures to Control Defects - Part I

Lecture 48 - Remedial Measures to Control Defects - Part II

Lecture 49 - Remedial Measures to Control Defects - Part III

Lecture 50 - Grade - Specific Casting Parameters - Part I

Lecture 51 - Grade - Specific Casting Parameters - Part II

Lecture 52 - Identification of Genesis of Quality Problems Through Metallographic Investigation - Part I

Lecture 53 - Identification of Genesis of Quality Problems Through Metallographic Investigation - Part II

Lecture 54 - Identification of Genesis of Quality Problems Through Metallographic Investigation - Part III

Lecture 55 - Some Examples of Quality Problems

Lecture 1 - Review of Kinematics Fundamentals-I

Lecture 2 - Links, Pairs, Kinematic Chains; Planar Mobility Criterion

Lecture 3 - Mobility of Mechanisms, Grubler's Criterion and Applications

Lecture 4 - Inversions, Grashof Criterion, Kinematic equivalence

Lecture 5 - Linkage Synthesis Classification, 2-position Motion Generation

Lecture 6 - Driver dyad, Quick-return synthesis - I

Lecture 7 - Quick-return synthesis - II, 3-position Motion Generation

Lecture 8 - Specified fixed pivots, Path generation

Lecture 9 - Function generation

Lecture 10 - Function generation using relative poles

Lecture 11 - Structural Error, and Chebyshev Spacing

Lecture 12 - Chebyshev Spacing

Lecture 13 - Analytical Linkage Synthesis-I: Vector Loop Closure, Freudenstein's method

Lecture 14 - Analytical Linkage Synthesis-II: Bloch's method, Driver Dyad

Lecture 15 - Four-bar Position Analysis, Dyad or Standard Form Synthesis

Lecture 16 - Dyad Form Synthesis: Motion Generation

Lecture 17 - Dyad Form Synthesis: Path and Function Generation

Lecture 18 - Dyad Form Synthesis: Multi loop linkages

Lecture 19 - Dyad Form Synthesis: Four Position Motion Generation

Lecture 20 - Coupler Curves - I

Lecture 21 - Coupler Curves - II, Fixed and Moving Centroids

Lecture 22 - Coupler Curves - III, Symmetrical Coupler Curves

Lecture 23 - Roberts-Chebyshev Theorem

Lecture 24 - Cognates

Lecture 25 - Velocity Analysis: Review of Velocity Polygons

Lecture 26 - Velocity Analysis: Velocity Polygons (Continued...) and Instant Centres

Lecture 27 - Velocity Analysis: Auxiliary Point Method

Lecture 28 - Auxiliary Point Method: (Continued...)

Lecture 29 - Velocity and Acceleration Analysis: Analytical Method

Lecture 30 - Acceleration Analysis: Analytical Method (Continued...)

Lecture 31 - Acceleration Analysis: Auxiliary Point Method

[Lecture 32 - Force Analysis of Mechanisms, Mechanical Advantage](#)

[Lecture 33 - Force Analysis of Mechanisms - II](#)

[Lecture 34 - Balancing of Mechanisms using Counterweights](#)

[Lecture 35 - Balancing of Mechanisms using Springs](#)

[Lecture 36 - Spatial Mechanisms](#)

[Lecture 37 - Introduction to the Kinematics of Spatial Mechanisms](#)

Lecture 1 - Introduction to Engineering Mechanics - I

Lecture 2 - Introduction to Engineering Mechanics - II

Lecture 3 - Force Systems - I

Lecture 4 - Force Systems - II

Lecture 5 - Equilibrium of Rigid bodies - I

Lecture 6 - Equilibrium of Rigid bodies - II

Lecture 7 - Trusses - I

Lecture 8 - Trusses - II

Lecture 9 - Trusses - III

Lecture 10 - Beams - I

Lecture 11 - Beams - II

Lecture 12 - Beams - III

Lecture 13 - Beams - IV

Lecture 14 - Virtual Work - I

Lecture 15 - Virtual Work - II

Lecture 16 - Energy Relations

Lecture 17 - Review Before Quiz - I

Lecture 18 - Friction - I

Lecture 19 - Friction - II

Lecture 20 - Friction - III

Lecture 21 - Particle Dynamics

Lecture 22 - Circular Motion

Lecture 23 - Absolute Motion

Lecture 24 - Relative Motion - I

Lecture 25 - Relative Motion - II

Lecture 26 - Relative Motion - III and Instantaneous Center

Lecture 27 - Rotating frame of reference I - Velocity

Lecture 28 - Rotating frame of reference II - Acceleration

Lecture 29 - Rotating frame of reference III - Choice of rotating frame of reference

Lecture 30 - RFR- IV Crank and slotted bar

Lecture 31 - RFR-V Understanding Coriolis Acceleration



[Lecture 32 - Kinetics - I](#)

[Lecture 33 - Kinetics - II](#)

[Lecture 34 - Kinetics - III](#)

[Lecture 35 - 3D Kinematics - I](#)

[Lecture 36 - 3D Kinematics - II](#)

[Lecture 37 - 3D Kinematics - III](#)

Lecture 1 - Introduction to the course

Lecture 2 - Some applications of MD simulations

Lecture 3 - Introduction to Bravais lattices and constructing simple crystals with MATLAB

Lecture 4 - Introduction to symmetry - 1

Lecture 5 - Symmetry Elements - 1

Lecture 6 - Symmetry elements - 2

Lecture 7 - Plane groups and their Hermann-Mauguin (HM) symbols

Lecture 8 - Glide reflection; Examples of writing point group symbols; Wyckoff positions

Lecture 9 - Generating 2D crystal with MATLAB using Bilbao crystallography website

Lecture 10 - Symmetry of space groups

Lecture 11 - Hermann mauguin symbols of space groups

Lecture 12 - Translational symmetry operators

Lecture 13 - The Space groups

Lecture 14 - Generation of crystals

Lecture 15 - Generation of monoclinic lattice

Lecture 16 - Introduction to Statistical Mechanics - 1

Lecture 17 - Introduction to Statistical Mechanics - 2

Lecture 18 - Introduction to Statistical Mechanics - 3

Lecture 19 - Statistical mechanics - 1

Lecture 20 - Statistical mechanics - 2

Lecture 21 - Basic introduction to mechanics

Lecture 22 - Introduction to phase space

Lecture 23 - Introduction to phase average and time average

Lecture 24 - Canonical ensemble; Partition function

Lecture 25 - Basic introduction to MD

Lecture 26 - Input script for LAMMPS - 1

Lecture 27 - Input script for LAMMPS - 2

Lecture 28 - Input script for LAMMPS - 3

Lecture 29 - Input script for LAMMPS - 4

Lecture 30 - LAMMPS exercises - 1

Lecture 31 - LAMMPS exercises - 2

[Lecture 32 - LAMMPS exercises - 3](#)

[Lecture 33 - LAMMPS exercises - 4](#)

[Lecture 34 - LAMMPS exercises - 5](#)

Lecture 1 - Introduction

Lecture 2 - Combustion processes in ICE and Gas turbine engines

Lecture 3 - Combustion in solid and liquid rocket motors

Lecture 4 - Equilibrium

Lecture 5 - Chemical kinetics, Equilibrium vs rate controlled

Lecture 6 - Demonstration of NASA-CEA

Lecture 7 - Premixed and diffusion flames: principal features and differences - Part I

Lecture 8 - Premixed and diffusion flames: principal features and differences - Part II

Lecture 9 - Quenching, flammability and other limit phenomena

Lecture 10 - Conservation equations

Lecture 11 - Integral Analysis of flame

Lecture 12 - Solid propellant combustion

Lecture 13 - Erosive burning

Lecture 14 - Instability in solid rockets

Lecture 15 - Analysis of p-t traces - Part II

Lecture 16 - Statistical representation of composite propellants in HeQu1D - geometry and thermochemistry

Lecture 17 - HeQu1D model - Parameter estimation

Lecture 18 - Effects of Al - extended HeQu1D model

Lecture 19 - Instability in solid rockets - II

Lecture 20 - Tutorial

Lecture 21 - Liquid propellant rockets - Part I

Lecture 22 - Liquid propellant rockets - Part II

Lecture 23 - Combustion in liquid rockets

Lecture 24 - Instabilities in liquid rockets and gas turbine after burners

Lecture 25 - CFD modeling aspects - Fundamentals

Lecture 26 - CFD modeling aspects - Modeling approaches

Lecture 27 - Effect of turbulence on flames

Lecture 28 - Scramjets - Part I

Lecture 29 - Scramjets - Part II

Lecture 30 - Summary - Premixed flames

Lecture 31 - Summary - Non-premixed flames

[Lecture 32 - Summary - Solid rocket propulsion](#)

[Lecture 33 - Additional Insights](#)

Lecture 1 - Introduction

Lecture 2 - Material Property Landscape

Lecture 3 - Crystal Structure-1 (Platonic Solids)

Lecture 4 - Crystal Structure-2 (Unit Cell, Lattice, Crystal)

Lecture 5 - Crystal Structure-3 (Bravais lattice, Symmetry in Crystals)

Lecture 6 - Crystal Structure-4 (Miller Indices for Crystallographic Points and Directions)

Lecture 7 - Crystal Structure-5 (Miller-Bravais Indices, Linear and Planar Density)

Lecture 8 - Crystal Structure-6 (Planar density, Close-Packed Structures, Stacking Faults)

Lecture 9 - Crystal Structure-7 (Single Crystal and Polycrystalline Materials)

Lecture 10 - Crystal Structure-8 (X-Ray Diffraction and Determination of Structure)

Lecture 11 - Defects in Crystalline Materials-1 (Types of Crystalline Defects)

Lecture 12 - Defects in Crystalline Materials-1 (Point Defects)

Lecture 13 - Defects in Crystalline Materials-1 (Equilibrium Concentration of Vacancies)

Lecture 14 - Defects in Crystalline Materials-1 (Theoretical Shear Strength)

Lecture 15 - Defects in Crystalline Materials-2 (Effect of Point Defects)

Lecture 16 - Defects in Crystalline Materials-2 (Point Defects and Solid Solutions)

Lecture 17 - Defects in Crystalline Materials-3 (Line Defects, Types of Dislocations and their Characteristics)

Lecture 18 - Defects in Crystalline Materials-4 (Slip Systems, Burger's Vector and Dislocation Motion)

Lecture 19 - Defects in Crystalline Materials-4 (Slip in Single Crystals and Resolved Shear Stress)

Lecture 20 - Defects in Crystalline Materials-5 (Different Stages of Slip in Single Crystla Materials)

Lecture 21 - Defects in Crystalline Materials-5 (Geometry and Slip, Stress Field Around a Dislocation and Deformation Twinning)

Lecture 22 - Defects in Crystalline Materials-6 (Twinning, Interfacial Defects and Volume Defects)

Lecture 23 - Defects in Crystalline Materials-6 (Strengthening Mechanisms)

Lecture 24 - Defects in Crystalline Materials-7 (Plastic deformation in polycrystalline materials, Softening Mechanisms)

Lecture 25 - Mechanical Properties of Materials (Concept of Stress Tensor)

Lecture 26 - Mechanical Properties (Tension Test-Elastic Deformation)

Lecture 27 - Mechanical Properties (Tension Test - Plastic Deformation)

Lecture 28 - Mechanical Properties (Tension Test - Plastic Deformation)

Lecture 29 - Mechanical Properties (Hardness Test)

Lecture 30 - Static Failure Theories (Introduction, Definition of Failure)

Lecture 31 - Static Failure Theories (General form of failure theory, Stress tensor, Principal stress)

Lecture 32 - Static Failure Theories (Distortion Energy Theory)

Lecture 33 - Static Failure Theories (Maximum Shear Stress Theory)

Lecture 34 - Static Failure Theories (Design Problems)

Lecture 35 - Static Failure Theories (Failure of Brittle Materials)

Lecture 36 - Static Failure Theories (Coulomb-Mohr and Modified Coulomb-Mohr)

Lecture 37 - Static Failure Theories (Notches and Stress Concentration)

Lecture 38 - Introduction to Fracture Mechanics, Griffith's Analysis of a Cracked Body

Lecture 39 - Fracture Mechanics (Energy Release Rate)

Lecture 40 - Fracture Mechanics (Crack Resistance, Stress Intensity Factor, Fracture Toughness)

Lecture 41 - Fatigue Failure of Materials (Introduction, Historical Events, S-N Diagram)

Lecture 42 - Fatigue Failure of Materials (S-N Diagram, Types of Time Varying Loads)

Lecture 43 - Fatigue Failure of Materials (High Cycle Fatigue, Low Cycle Fatigue, Stress Ratio, Amplitude Ratio)

Lecture 44 - Fatigue Failure of Materials (Rotating Beam Bending Test, Estimated S-N diagram)

Lecture 45 - Fatigue Failure Theories (Fatigue strength correction factors)

Lecture 46 - Problems on Fatigue Failure-1 (S-N diagram and Corrected endurance strength)

Lecture 47 - Fatigue Failure of Materials (Features of Fatigue Failure; Factor of Safety in Life and Stress)

Lecture 48 - Fatigue Failure of Materials (Effect of Mean Stress)

Lecture 49 - Fatigue Failure of Materials (Multiaxial Fatigue and Variable Amplitude Loading)

Lecture 50 - Fatigue Failure of Materials (Fatigue Stress Concentration Factor)

Lecture 51 - Fatigue Failure of Materials (Fatigue Crack Growth, Paris' law)

Lecture 52 - Problems on Fatigue Failure-2 (Effect of mean stress, Fatigue crack growth)

Lecture 53 - Problems on Fatigue Failure-3 (Effect of Notch, Multiaxial Loading)

Lecture 54 - Phase Diagrams (Introduction)

Lecture 55 - Phase Diagrams (Language of Phase Diagrams, Types of Binary Phase Alloys)

Lecture 56 - Phase Diagrams (Tie line, Lever Rule, Identification of compositions and weight fractions in two-phase regions)

Lecture 57 - Phase Diagrams (Type I: Isomorphous Alloys, Microstructure evolution in Equilibrium and Non equilibrium cooling)

Lecture 58 - Phase Diagrams (Congruent Melting Alloys, Type II Alloys, Eutectic Reaction)

Lecture 59 - Phase Diagrams (Type III Alloys with Partial Solubility in Solid State)

Lecture 60 - Phase Diagrams (Congruent melting alloys, Peritectic Reaction, Monotectic Reaction)

Lecture 61 - Phase Diagrams (Allotropy, Eutectoid and Peritectoid Reactions)

Lecture 62 - Phase Diagrams (Iron-Iron Carbide Phase Diagram)

Lecture 63 - Kinetics of Phase Transformations (Homogeneous Nucleation)

Lecture 64 - Kinetics of Phase Transformations (Heterogeneous Nucleation)

[Lecture 65 - Isothermal Transformation Diagram](#)

[Lecture 66 - Martensite Transformation, C-C-T Diagram](#)

[Lecture 67 - Heat Treatment of Steels \(Annealing and Normalizing\)](#)



Lecture 1 - Review of governing equations: Conservation of mass

Lecture 2 - Review of governing equations: Conservation of momentum

Lecture 3 - Review of governing equations: Conservation of energy

Lecture 4 - Review of governing equations: Navier-Stokes equations and energy equation

Lecture 5 - Review of governing equations: General scalar transport equation

Lecture 6 - Review of governing equations: classification of PDEs

Lecture 7 - Overview of Numerical Methods: Finite Difference Method

Lecture 8 - Overview of Numerical Methods: Finite Volume Method

Lecture 9 - Overview of Numerical Methods: Solution of linear algebraic equations

Lecture 10 - Finite Volume Method for Diffusion Equation: Discretization of 1D diffusion equation

Lecture 11 - Finite Volume Method for Diffusion Equation: Discretization of 2D diffusion equation

Lecture 12 - Finite Volume Method for Diffusion Equation: Boundary conditions for 2D diffusion equation

Lecture 13 - Finite Volume Method for Diffusion Equation: Discretization of 3D diffusion equation, mixed boundary conditions

Lecture 14 - Finite Volume Method for Diffusion Equation: Tri-Diagonal Matrix Algorithm

Lecture 15 - Finite Volume Method for Diffusion Equation: Linearization of source term, line-by-line TDMA

Lecture 16 - Finite Volume Method for Diffusion Equation: Problem solving using TDMA

Lecture 17 - Finite Volume Method for Diffusion Equation: Problem solving using line-by-line TDMA

Lecture 18 - Finite Volume Method for Diffusion Equation: Steady diffusion in polar and axisymmetric coordinates

Lecture 19 - Finite Volume Method for Diffusion Equation: Discretization of unsteady diffusion equation

Lecture 20 - Finite Volume Method for Diffusion Equation: Unsteady diffusion time-stepping schemes

Lecture 21 - Finite Volume Method for Diffusion Equation: Unsteady diffusion time-stepping schemes and Truncation errors of the FV schemes

Lecture 22 - Finite Volume Method for Diffusion Equation: Truncation errors and stability analysis

Lecture 23 - Finite Volume Method for Diffusion Equation: Stability analysis and steady diffusion in unstructured meshes.

Lecture 24 - Finite Volume Method for Diffusion Equation: Steady diffusion in unstructured meshes - Part 1

Lecture 25 - Finite Volume Method for Diffusion Equation: Steady diffusion in unstructured meshes - Part 2

Lecture 26 - Finite Volume Method for Diffusion Equation: Steady diffusion in unstructured meshes - Part 3

Lecture 27 - Finite Volume Method for Diffusion Equation: Steady diffusion in unstructured meshes - Part 4

Lecture 28 - Finite Volume Method for Diffusion Equation: Steady diffusion in unstructured meshes - Part 5

Lecture 29 - Finite Volume Method for Convection and Diffusion: Discretization of steady convection equation

Lecture 30 - Finite Volume Method for Convection and Diffusion: Discretization of steady convection equation

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[Lecture 31 - Finite Volume Method for Convection and Diffusion: Discretization of steady and unsteady convection equation](#)

[Lecture 32 - Finite Volume Method for Convection and Diffusion: Discretization of unsteady convection equation](#)

[Lecture 33 - Finite Volume Method for Convection and Diffusion: Discretization of convection-diffusion equation on unstructured mesh](#)

[Lecture 34 - Finite Volume Method for Convection-diffusion and fluid flow calculations](#)

[Lecture 35 - Finite Volume Method for Fluid Flow Calculations: The staggered grid approach](#)

[Lecture 36 - Finite Volume Method for Fluid Flow Calculations: SIMPLE algorithm - Part 1](#)

[Lecture 37 - Finite Volume Method for Fluid Flow Calculations: SIMPLE algorithm - Part 2](#)

[Lecture 38 - Finite Volume Method for Fluid Flow Calculations: SIMPLE algorithm - Part 3](#)

[Lecture 39 - Finite Volume Method for Fluid Flow Calculations: SIMPLE-Revised and SIMPLE-Corrected algorithm](#)

[Lecture 40 - Finite Volume Method for Fluid Flow Calculations: SIMPLE algorithm for Colocated mesh - Part 1](#)

[Lecture 41 - Finite Volume Method for Fluid Flow Calculations: SIMPLE algorithm for Colocated mesh - Part 2](#)

[Lecture 42 - Finite Volume Method for Fluid Flow Calculations: SIMPLE-Colocated algorithm for Unstructured mesh](#)

Lecture 1 - Introduction to Mobile Robots and Manipulators

Lecture 2 - Introduction to Locomotion and Types of Locomotion

Lecture 3 - Introduction to Mobile Robot Kinematics

Lecture 4 - Degree of Maneuverability and Types of Wheels

Lecture 5 - Kinematic Simulation of a Mobile Robot (Land-based)

Lecture 6 - Kinematic Simulation and Motion Animation of a Mobile Robot (Land-based)

Lecture 7 - A Generalized Wheel (Kinematic) Model

Lecture 8 - Examples related to the Generalized Wheel (Kinematic) Model

Lecture 9 - Holonomic and Non-holonomic Mobile Robots

Lecture 10 - Kinematic Simulation of Wheeled Mobile Robots - Part 1

Lecture 11 - Kinematic Simulation of Wheeled Mobile Robots - Part 2

Lecture 12 - Kinematic Simulation of Wheeled Mobile Robots - Part 3

Lecture 13 - Mobile Robot Dynamics - Part 1

Lecture 14 - Mobile Robot Dynamics - Part 2

Lecture 15 - Equation of Motion and Dynamic Simulation of a Mobile Robot

Lecture 16 - Dynamic Models of Wheeled Mobile Robots with Wheel Configurations

Lecture 17 - Kinematic and Dynamic Models of a Mobile base with Four-Independent Steerable Power Wheels

Lecture 18 - Sensing and Perception

Lecture 19 - Sensors and Sensing

Lecture 20 - Commonly used sensors - 1

Lecture 21 - Commonly used sensors - 2

Lecture 22 - Commonly used sensors - 3

Lecture 23 - Sensor Errors and Error modelling

Lecture 24 - Mobile Robot Localisation

Lecture 25 - Map based Localisation

Lecture 26 - Markov Localisation

Lecture 27 - Kalman Filter Localisation

Lecture 28 - SLAM

Lecture 29 - Mobile Robot Navigation

Lecture 30 - Path Planning: Graph Construction

Lecture 31 - Graph Search Methods

[Lecture 32 - Path Planning and Obstacle avoidance](#)

[Lecture 33 - Introduction to Motion Control of Mobile Robots - Part 1](#)

[Lecture 34 - Introduction to Motion Control of Mobile Robots - Part 2](#)

[Lecture 35 - Kinematic control of Land-based Mobile Robots](#)

[Lecture 36 - Simulation of Land-based Mobile Robots along with Kinematic Control - Part 1](#)

[Lecture 37 - Simulation of Land-based Mobile Robots along with Kinematic Control - Part 2](#)

[Lecture 38 - Simulation of Land-based Mobile Robots along with Kinematic Control - Part 3](#)

[Lecture 39 - Dynamic Control of Mobile Robots](#)

[Lecture 40 - Cascaded or Back-stepping Control of Mobile Robots](#)

[Lecture 41 - Modern Robotics and Challenges](#)

[Lecture 42 - Multiple Mobile Robotic Systems](#)

[Lecture 43 - Autonomous Mobile Robots and Mobile Manipulators](#)

[Lecture 44 - Legged and Hybrid Robots](#)

[Lecture 45 - Underwater and Aerial Robots](#)

[Lecture 46 - Healthcare Robots](#)

Lecture 1 - Fuel and their properties - Part 1

Lecture 2 - Fuel and their properties - Part 2 - Gaseous and Liquid fuels

Lecture 3 - Fuel and their properties - Part 3 - Liquid and Solid fuels

Lecture 4 - Review of basic thermodynamics of ideal gas mixtures - Part 1

Lecture 5 - Review of basic thermodynamics of ideal gas mixtures - Part 2

Lecture 6 - Stoichiometry - Part 1

Lecture 7 - Stoichiometry - Part 2 - Worked Examples

Lecture 8 - Stoichiometry - Part 3 - Worked Examples (Continued...)

Lecture 9 - First law and Second law of thermodynamics applied to combustion - Part 1 - Heat Calculation

Lecture 10 - First law and Second law of thermodynamics applied to combustion - Part 2 - Enthalpy Calculation

Lecture 11 - First law and Second law of thermodynamics applied to combustion - Part 3 - Calculation of flame temperature

Lecture 12 - First law and Second law of thermodynamics applied to combustion - Part 4 - Chemical equilibrium

Lecture 13 - First law and Second law of thermodynamics applied to combustion - Part 5 - Chemical equilibrium (Continued...)

Lecture 14 - First law and Second law of thermodynamics applied to combustion - Part 6 - Worked examples

Lecture 15 - First law and Second law of thermodynamics applied to combustion - Part 7 - Worked examples (Continued...)

Lecture 16 - Mass transfer basics - Part 1 - Fundamentals

Lecture 17 - Mass transfer basics - Part 2 - Calculation of diffusion velocity

Lecture 18 - Mass transfer basics - Part 3 - Steady evaporation (The Stefan Problem)

Lecture 19 - Mass transfer basics - Part 4 - Steady evaporation of liquid droplet and Worked examples

Lecture 20 - Fundamentals of combustion kinetics - Part 1 - Global and elementary reactions

Lecture 21 - Fundamentals of combustion kinetics - Part 2 - Reaction rates and equilibrium constant

Lecture 22 - Fundamentals of combustion kinetics - Part 3 - Steady state and partial equilibrium approximation

Lecture 23 - Fundamentals of combustion kinetics - Part 4 - Worked examples

Lecture 24 - Governing equations for reacting flow - Part 1 - Continuity, momentum and species conservation equations

Lecture 25 - Governing equations for reacting flow - Part 2 - The energy equation

Lecture 26 - Governing equations for reacting flow - Part 3 - Estimation of thermo-physical properties and control of combustion phenomena

Lecture 27 - Governing equations for reacting flow - Part 4 - Control of combustion phenomena and simplified chemically reacting system

Lecture 28 - Governing equations for reacting flow - Part 5 - Conserved scalars and mixture fraction approach

Lecture 29 - Characteristics of combustion flame and detonation - Part 1

Lecture 30 - Characteristics of combustion flame and detonation - Part 2

- Lecture 31 - Characteristics of combustion flame and detonation - Part 3 - Rankine-Hugoniot relation
- Lecture 32 - Characteristics of combustion flame and detonation - Part 4 - Estimation of detonation velocity and Worked examples
- Lecture 33 - Laminar Premixed Flames - Part 1 - Laminar flame propagation
- Lecture 34 - Laminar Premixed Flames - Part 2 - Laminar flame speed variation and Structure of premixed flames
- Lecture 35 - Laminar Premixed Flames - Part 3 - Flammability limits and Premixed flame theory
- Lecture 36 - Laminar Premixed Flames - Part 4 - Estimation of laminar flame speed
- Lecture 37 - Laminar Premixed Flames - Part 5 - Ignition of premixed mixture (Semenov's Analysis)
- Lecture 38 - Laminar Premixed Flames - Part 6 - Piloted ignition and Flame quenching
- Lecture 39 - Laminar Premixed Flames - Part 7 - Premixed flame stability
- Lecture 40 - Laminar Premixed Flames - Part 8 - Stability Maps and Worked examples
- Lecture 41 - Laminar Diffusion Flames - Part 1 - Theory of gas jets
- Lecture 42 - Laminar Diffusion Flames - Part 2 - Analysis of gas jets and jet diffusion flames
- Lecture 43 - Laminar Diffusion Flames - Part 3 - Diffusion flame characteristics and flame structure
- Lecture 44 - Laminar Diffusion Flames - Part 4 - Diffusion flame structure and Flame regimes
- Lecture 45 - Laminar Diffusion Flames - Part 5 - Diffusion flame regimes and Flame height correlations
- Lecture 46 - Laminar Diffusion Flames - Part 6 - Diffusion flame control
- Lecture 47 - Laminar Diffusion Flames - Part 7 - Diffusion flame configurations (coflow, crossflow and opposed flow flames)
- Lecture 48 - Laminar Diffusion Flames - Part 8 - Diffusion flame stability and Worked examples
- Lecture 49 - Turbulent Flames - Part 1 - Characteristics of turbulence
- Lecture 50 - Turbulent Flames - Part 2 - Turbulent length scales and turbulent stresses
- Lecture 51 - Turbulent Flames - Part 3 - Axisymmetric turbulent jet
- Lecture 52 - Turbulent Flames - Part 4 - Turbulent premixed flames and flame regimes
- Lecture 53 - Turbulent Flames - Part 5 - Turbulent diffusion flames
- Lecture 54 - Droplet evaporation and combustion - Part 1 - Steady evaporation of liquid droplet
- Lecture 55 - Droplet evaporation and combustion - Part 2 - Equilibrium under steady evaporation of liquid droplet and droplet combustion
- Lecture 56 - Droplet evaporation and combustion - Part 3 - Droplet combustion (simplified analysis)
- Lecture 57 - Droplet evaporation and combustion - Part 4 - Species and temperature profiles
- Lecture 58 - Droplet evaporation and combustion - Part 5 - Evaluation of mass burning rate and worked examples
- Lecture 59 - Combustion of carbon particle - Part 1 - Coal combustion
- Lecture 60 - Combustion of carbon particle - Part 2 - One film model
- Lecture 61 - Combustion of carbon particle - Part 3 - Two film model and worked examples

Lecture 1 - Introduction, Learning Objectives, Course Content and References

Lecture 2 - Merits and Demerits of Fluid Power, Power Transmission Method

Lecture 3 - Brief History, Application Areas, Major Divisions of Fluid Power System

Lecture 4 - Introduction to Oil Hydraulics and its Basic Components

Lecture 5 - Introduction to Pneumatic and its Basic Components, Applications-Stationary and Mobile

Lecture 6 - Typical Application of Fluid Power System, Status and Development

Lecture 7 - Pascal's law and its application-Hydraulic jack, Hydraulic brake and Numerical

Lecture 8 - Pressure Intensifier, Numericals, Air-to-Hydraulic Booster and Bernoulli equation

Lecture 9 - Applications of Bernoulli equation-Venturi, Torricelli's theorem, Siphon, Continuity equation and flow configuration, Concept of pressures and Gas laws

Lecture 10 - Introduction to Fluid Power Symbols, Hydraulic lines and Color Coding

Lecture 11 - Symbols for Functional Units, Hydraulic Pumps, Hydraulic Motors, Cylinders, Air Compressors, Pneumatic Motors and Orifices

Lecture 12 - Symbols for Filters, Check Valves, DCVs, Spool Actuation methods, PCV, Miscellaneous, Port Configurations

Lecture 13 - Introduction to Hydraulic Pumps, Facts and Figures, Classifications

Lecture 14 - Positive Displacement pump and pumping theory

Lecture 15 - Ideal pump, pump losses, efficiency curve, Constructional features and Operations of External Gear pump

Lecture 16 - Construction features and operations of Internal Gear Pump, Gerotor Pump and Screw Pump

Lecture 17 - Numericals on Gear Pump, Tree Structure of Vane Pump

Lecture 18 - Vane Pump, Pumping theory, Construction and Operation of Unbalanced Vane Pump, Vane loading and solutions, Different Vanes

Lecture 19 - Variable Displacement Pressure Compensated Vane Pump, Balance Vane Pump, Kinematic Inversion of Vane pump and Numerical

Lecture 20 - Piston pump, Pumping theory, Constructional features and Operations of Hand Pump-Single acting, Twin single acting, Double acting, Two-stage

Lecture 21 - Axial Piston Pump- Construction and Operating principles of Bent axis and Swash plate type pump

Lecture 22 - Radial Piston Pumps- Construction and Operation, Pump failure and Cavitations, Important parameters while selecting Pump, Numerical

Lecture 23 - Pneumatic Control System-Introduction, Air preparation-Primary and Secondary Air Treatment

Lecture 24 - Pneumatic Power Source- Compressor, Classification, Air Receiver and Control Methods

Lecture 25 - Reciprocating Type Air Compressor-Single and Multi-stage Piston Pump, PV Diagram and Work Done

Lecture 26 - Construction and Operation of Two-stage Reciprocating type Air Compressor, Diaphragm Type Air Compressor, Rotary Vane Compressor, Twin Lobe Air compressor, Screw Compressor, Liquid Ring Compressor and Selection Criteria

Lecture 27 - Energy Loss and Cost Break Down in Air Preparation Process, Pressure Drop and its Effect

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Lecture 28 - What causes Pressure Drop ?, Minimising Pressure Drop, Air Distribution System- Sizing of Pipes, Tubes, Materials and Fittings, Important Air Flow Parameters

Lecture 29 - Pressure drop Predictions using Various Empirical Formulae and Nomogram, Best Practices for Compressed Air Piping System and Installation Tips

Lecture 30 - Need for Air Dryer, Analysis of Moisture Removal from Air, Typical Air Drying Methods, Basic Types of Air Dryers

Lecture 31 - Construction and Operation of Refrigerated Air dryers, Absorption Dryer, Adsorption Dryer, Membrane Dryer, How to Choose the Right Air Dryer?

Lecture 32 - Directional Control Valves

Lecture 33 - Directional Control Valves

Lecture 34 - Directional Control Valves

Lecture 35 - Directional Control Valves

Lecture 36 - Directional Control Valves

Lecture 37 - Pressure Control Valves

Lecture 38 - Pressure Control Valves

Lecture 39 - Pressure Control Valves

Lecture 40 - Flow Control Valves

Lecture 41 - Flow Control Valves

Lecture 42 - Flow Control Valves

Lecture 43 - Estimation of leakage through spool and housing bore and Numericals on DCV, PCV and FCV

Lecture 44 - Estimation of leakage through spool and housing bore and Numericals on DCV, PCV and FCV

Lecture 45 - Hydraulic Motors

Lecture 46 - Hydraulic Motors

Lecture 47 - Hydraulic Motors

Lecture 48 - Hydraulic Motors

Lecture 49 - Hydraulic Motors

Lecture 50 - Hydraulic Motors

Lecture 51 - Hydraulic Cylinders

Lecture 52 - Hydraulic Cylinders

Lecture 53 - Hydraulic Cylinders

Lecture 54 - Hydraulic Cylinders

Lecture 55 - Hydraulic Cylinders

Lecture 56 - Numericals on Fluid Power Actuators

Lecture 57 - Numericals on Fluid Power Actuators

Lecture 58 - Subsystems: Hydraulic Reservoir, Coolers and Filters

Lecture 59 - Subsystems: Hydraulic Reservoir, Coolers and Filters



Lecture 60 - Subsystems: Hydraulic Reservoir, Coolers and Filters

Lecture 61 - Subsystems: Hydraulic Fluids, Conduits and Simple Numericals

Lecture 62 - Subsystems: Hydraulic Fluids, Conduits and Simple Numericals

Lecture 63 - Subsystems: Hydraulic Fluids, Conduits and Simple Numericals

Lecture 64 - Subsystems: Hydraulic accumulators, Classifications, Applications, Accumulator physics, Maintenance, Numericals

Lecture 65 - Subsystems: Hydraulic accumulators, Classifications, Applications, Accumulator physics, Maintenance, Numericals

Lecture 66 - Subsystems: Hydraulic accumulators, Classifications, Applications, Accumulator physics, Maintenance, Numericals

Lecture 67 - Oil Hydraulic Circuits: Design and Analysis

Lecture 68 - Oil Hydraulic Circuits: Design and Analysis

Lecture 69 - Oil Hydraulic Circuits: Design and Analysis

Lecture 70 - Task Based Selection and Analysis of Oil Hydraulic Circuits

Lecture 71 - Task Based Selection and Analysis of Oil Hydraulic Circuits

Lecture 72 - Task Based Selection and Analysis of Oil Hydraulic Circuits

Lecture 73 - Task Based Selection and Analysis of Oil Hydraulic Circuits

Lecture 74 - Pneumatic Circuits: Design and Analysis

Lecture 75 - Pneumatic Circuits: Design and Analysis

Lecture 76 - Pneumatic Circuits: Design and Analysis

Lecture 77 - Pneumatic Circuits: Design and Analysis of Multiple Actuators

Lecture 78 - Pneumatic Circuits: Design and Analysis of Multiple Actuators

Lecture 79 - Pneumatic Circuits: Design and Analysis of Multiple Actuators

Lecture 80 - Pump-controlled Hydraulic Systems

Lecture 81 - Pump-controlled Hydraulic Systems

Lecture 82 - Pump-controlled Hydraulic Systems

Lecture 83 - Hydrostatic Transmissions

Lecture 84 - Hydrostatic Transmissions

Lecture 85 - Hydrostatic Transmissions

Lecture 86 - Proportional Valve Technology

Lecture 87 - Proportional Valve Technology

Lecture 88 - Proportional Valve Technology

Lecture 89 - Electro Hydraulic Servo Valve (EHSV)

Lecture 90 - Electro Hydraulic Servo Valve (EHSV)

Lecture 91 - Electro Hydraulic Servo Valve (EHSV)

Lecture 92 - Electro-Hydraulic Actuator (EHA)

[Lecture 93 - Electro-Hydraulic Actuator \(EHA\)](#)

[Lecture 94 - Modeling and Simulation in Hydraulic Components](#)

[Lecture 95 - Modeling and Simulation in Hydraulic Components](#)

[Lecture 96 - Modeling and Simulation in Hydraulic Components](#)

Lecture 1 - Introduction

Lecture 2 - Basic Theory of Turbomachines - Part 1

Lecture 3 - Basic Theory of Turbomachines - Part 2

Lecture 4 - Basic Theory of Turbomachines - Part 3

Lecture 5 - Basic Theory of Turbomachines - Part 4

Lecture 6 - Basic Theory of Turbomachines - Part 5

Lecture 7 - Basic Theory of Turbomachines - Part 6

Lecture 8 - Hydro Turbomachines - Centrifugal pumps - Part 1

Lecture 9 - Hydro Turbomachines - Centrifugal pumps - Part 2

Lecture 10 - Hydro Turbomachines - Centrifugal pumps - Part 3

Lecture 11 - Hydro Turbomachines - Centrifugal pumps - Part 4

Lecture 12 - Hydro Turbomachines - Francis turbine - Part 1

Lecture 13 - Hydro Turbomachines - Francis turbine - Part 2

Lecture 14 - Hydro Turbomachines - Kaplan turbine

Lecture 15 - Hydro Turbomachines - Pelton turbine

Lecture 16 - Positive Displacement Pumps - Gear pump

Lecture 17 - Thermal Turbomachines - Introduction

Lecture 18 - Thermal Turbomachines - Gas turbines

Lecture 19 - Thermal Turbomachines - Steam Turbines

Lecture 20 - Thermal Turbomachines - Part 1

Lecture 21 - Thermal Turbomachines - Part 2

Lecture 1 - Introduction

Lecture 2 - Introduction to robot mechanics

Lecture 3 - Introduction to forward and inverse kinematics

Lecture 4 - Description of position and orientation

Lecture 5 - Transformation matrix

Lecture 6 - Compound rotations - Part 1

Lecture 7 - Compound rotations - Part 2

Lecture 8 - Kinematic parameters

Lecture 9 - DH parameters

Lecture 10 - DH representation

Lecture 11 - Frame arrangement and examples - Part 1

Lecture 12 - Examples related to frame arrangement

Lecture 13 - Frame arrangement and examples - Part 2

Lecture 14 - Forward and inverse kinematics of robotic manipulators

Lecture 15 - Examples related to inverse kinematics

Lecture 16 - Inverse kinematic solution based on numerical methods

Lecture 17 - Forward kinematic solution using Matlab

Lecture 18 - Inverse kinematic solution based on numerical methods using Matlab

Lecture 19 - Introduction to differential kinematics

Lecture 20 - Velocity propagation model for serial manipulators and Jacobian matrix

Lecture 21 - Velocity propagation model using Matlab

Lecture 22 - Manipulator Statics and Workspace singularities

Lecture 23 - Introduction to robot dynamics and Lagrange-Euler method

Lecture 24 - Newton-Euler method

Lecture 25 - Equation of motion in state-space form

Lecture 26 - Dynamic model derivation using Newton-Euler method in Matlab

Lecture 27 - Dynamic model derivation using Lagrange-Euler method in Matlab

Lecture 28 - Dynamic simulation of serial manipulators using Matlab

Lecture 29 - Introduction to trajectory generation

Lecture 30 - Trajectory generation using smooth functions

Lecture 31 - Trajectory generation schemes for serial manipulators

[Lecture 32 - Trajectory generation using Matlab - Part 1](#)

[Lecture 33 - Trajectory generation using Matlab - Part 2](#)

[Lecture 34 - Trajectory generation for serial manipulators using matlab](#)

[Lecture 35 - Trajectory generation for serial manipulators with workspace using matlab](#)

[Lecture 36 - Introduction to robot motion control](#)

[Lecture 37 - Types of robot manipulator control and concerns](#)

[Lecture 38 - Kinematic control](#)

[Lecture 39 - Matlab simulation on kinematic control](#)

[Lecture 40 - Dynamic control](#)

[Lecture 41 - Simulations related to dynamic control schemes using Matlab - Part 1](#)

[Lecture 42 - Cascaded control design](#)

[Lecture 43 - Simulations related to dynamic control schemes using Matlab - Part 2](#)

[Lecture 44 - Simulations related to dynamic control schemes using Matlab - Part 3](#)

[Lecture 45 - Kinematic and dynamic models of a mobile robot using DH approach](#)

Lecture 1 - Introduction to inverse problems

Lecture 2 - Fermi estimation

Lecture 3 - Forward/Direct and Inverse problems

Lecture 4 - Key drivers for studying inverse methods in engineering

Lecture 5 - Formulation for inverse problems

Lecture 6 - Statistical tools for estimation

Lecture 7 - Statistical description of errors

Lecture 8 - Well-posed and ill-posed problems

Lecture 9 - Probability and Statistics Brief overview - I

Lecture 10 - Probability and Statistics Brief overview - II

Lecture 11 - Gaussian distribution

Lecture 12 - Gaussian distribution (Continued...), and Maximum Likelihood Estimation (MLE)

Lecture 13 - Linear least square regression

Lecture 14 - Linear least square regression (Continued...)

Lecture 15 - Alternatives to Linear least square

Lecture 16 - Polynomial regression

Lecture 17 - Inverse problems in transient conduction - I

Lecture 18 - Inverse problems in transient conduction - II

Lecture 19 - Non-linear regression

Lecture 20 - Gauss-Newton algorithm (GNA)

Lecture 21 - Gauss-Newton algorithm (GNA) Example

Lecture 22 - Levenberg-Marquardt algorithm (LMA)

Lecture 23 - Tikhonov regularization

Lecture 24 - Jacobian and its calculation

Lecture 25 - Bayesian methods

Lecture 26 - Bayesian methods (Continued...)

Lecture 27 - Metropolis-Hastings algorithm (MH) and Markov Chain Monte Carlo Methods (MCMC)

Lecture 28 - Introduction to machine learning in heat transfer

Lecture 29 - Overview of machine learning

Lecture 30 - Calculation in a neural network model

Lecture 31 - Gradient Descent method

[Lecture 32 - Gradient Descent method \(Continued...\)](#)

[Lecture 33 - Back propagation](#)

[Lecture 34 - Neural network as a surrogate forward model](#)

[Lecture 35 - PINN for an inverse problem](#)

[Lecture 36 - PINN for an inverse problem \(Continued...\)](#)

[Lecture 37 - Inverse methods in heat transfer - Summary](#)

[Lecture 1 - Course outline](#)

[Lecture 2 - Introduction - Part 1](#)

[Lecture 3 - Introduction - Part 2](#)

[Lecture 4 - Basic concepts - Part 1](#)

[Lecture 5 - Basic concepts - Part 2](#)

[Lecture 6 - Basic concepts - Part 3](#)

[Lecture 7 - Basic concepts - Part 4](#)

[Lecture 8 - Basic concepts - Part 5](#)

[Lecture 9 - Work and Heat - Part 1](#)

[Lecture 10 - Work and Heat - Part 2](#)

[Lecture 11 - Work and Heat - Part 3](#)

[Lecture 12 - First law of thermodynamics](#)

[Lecture 13 - Pure substances](#)

[Lecture 14 - Ideal gases and ideal gas mixtures](#)

[Lecture 15 - Two-phase mixtures - Part 1](#)

[Lecture 16 - Two-phase mixtures - Part 2](#)

[Lecture 17 - First law analysis of systems - Part 1](#)

[Lecture 18 - First law analysis of systems - Part 2](#)

[Lecture 19 - First law analysis of systems - Part 3](#)

[Lecture 20 - First law analysis of systems - Part 4](#)

[Lecture 21 - First law of thermodynamics for a control volume](#)

[Lecture 22 - Control volume analysis of steady flow devices - Part 1](#)

[Lecture 23 - Control volume analysis of steady flow devices - Part 2](#)

[Lecture 24 - Control volume analysis of steady flow devices - Part 3](#)

[Lecture 25 - Unsteady analysis](#)

[Lecture 26 - Second law of Thermodynamics - Part 1](#)

[Lecture 27 - Second law of Thermodynamics - Part 2](#)

[Lecture 28 - Second law of Thermodynamics - Part 3](#)

[Lecture 29 - Second law of Thermodynamics - Part 4](#)

[Lecture 30 - Second law of Thermodynamics - Part 5](#)

[Lecture 31 - Entropy - Part 1](#)



[Lecture 32 - Entropy - Part 2](#)

[Lecture 33 - Entropy - Part 3](#)

[Lecture 34 - Entropy - Part 4](#)

[Lecture 35 - Entropy - Part 5](#)

[Lecture 36 - Entropy - Part 6](#)

[Lecture 37 - Thermodynamic cycles - Part 1](#)

[Lecture 38 - Thermodynamic cycles - Part 2](#)

[Lecture 1 - Free and Forced Vortices - I](#)

[Lecture 2 - Free and Forced Vortices - II](#)

[Lecture 3 - Impact of Jet on hemispherical shell](#)

[Lecture 4 - Impact of Jet on horizontal flat plate](#)

[Lecture 5 - Pressure Distribution on a Circular Cylinder](#)

[Lecture 6 - Verification of Bernoulli's Theorem](#)

[Lecture 7 - Visualization of potential flows](#)

[Lecture 8 - Visualization of vortex shedding](#)

[Lecture 9 - Wake Velocity Measurement for flow over a Circular Cylinder](#)

- Lecture 1 - Non-dimensional numbers in interfacial flows
- Lecture 2 - Integral form of governing equations
- Lecture 3 - Boundary (Jump) conditions at a fluid-fluid interface (no surface tension)
- Lecture 4 - On surface tension and interfacial energy
- Lecture 5 - Introduction to surface tension effects
- Lecture 6 - Boundary (Jump) conditions at a fluid-fluid interface (with surface tension) - Part 1
- Lecture 7 - Boundary (Jump) conditions at a fluid-fluid interface (with surface tension) - Part 2
- Lecture 8 - Summary of equations
- Lecture 9 - Capillary statics shape of meniscus - Part 1
- Lecture 10 - Capillary statics shape of meniscus - Part 2
- Lecture 11 - Shape of static meniscus-Energy minimisation - Part 1
- Lecture 12 - Calculus of variations (a primer): Euler-Lagrange equations
- Lecture 13 - Shape of static meniscus-Energy minimisation - Part 2
- Lecture 14 - Method of Lagrange multipliers
- Lecture 15 - On wetting and shape of a drop
- Lecture 16 - The Young's Equation: Partial wetting
- Lecture 17 - Variational approach to the Young-Laplace equation - Part 1
- Lecture 18 - Variational approach to the Young-Laplace equation - Part 2
- Lecture 19 - Shape of a puddle - large/heavy drops
- Lecture 20 - Wetting on rough and textured surface - Part 1
- Lecture 21 - Wetting on rough and textured surface - Part 2
- Lecture 22 - Wetting on rough and textured surface - Part 3
- Lecture 23 - Law of capillary rise
- Lecture 24 - Dynamics of capillary rise
- Lecture 25 - Dynamics of capillary rise: Analysis of regimes
- Lecture 26 - Forced wetting and coating flows
- Lecture 27 - More on coating and Landau-Levich equation
- Lecture 28 - Lubrication approximation and thin films
- Lecture 29 - Free surface flows and interface conditions
- Lecture 30 - Uniform flow down an incline
- Lecture 31 - Shape of a falling jet

- [Lecture 32 - A quick tour of stability analysis](#)
- [Lecture 33 - Rayleigh-Plateau instability - Part 1](#)
- [Lecture 34 - Rayleigh-Plateau instability - Part 2](#)
- [Lecture 35 - Rayleigh-Plateau instability - Part 3](#)
- [Lecture 36 - Rupture of thin films - Part 1](#)
- [Lecture 37 - Rupture of thin films - Part 2](#)
- [Lecture 38 - Rupture of thin films - Effect of van der Waals force](#)
- [Lecture 39 - Rupture of thin films - Part 3](#)
- [Lecture 40 - Rupture of thin films - Part 4](#)
- [Lecture 41 - Benard-Marangoni Instability - Part 1](#)
- [Lecture 42 - Benard-Marangoni Instability - Part 2](#)
- [Lecture 43 - Benard-Marangoni Instability - Part 3](#)
- [Lecture 44 - Benard-Marangoni Instability - Part 4](#)
- [Lecture 45 - Kelvin helmholtz instability - Part 1](#)
- [Lecture 46 - Kelvin helmholtz instability - Part 2](#)
- [Lecture 47 - Kelvin helmholtz instability - Part 3](#)
- [Lecture 48 - Kelvin helmholtz instability - Part 4](#)
- [Lecture 49 - Contact angle hysteresis](#)
- [Lecture 50 - Thin film down an incline-a contact line problem - Part 1](#)
- [Lecture 51 - Thin film down an incline-a contact line problem - Part 2](#)
- [Lecture 52 - Local flow near a moving contact line](#)
- [Lecture 53 - Modelling of moving contact line](#)

Lecture 1 - Introduction

Lecture 2 - Entropy change of a control volume - Part 1

Lecture 3 - Entropy change of a control volume - Part 2

Lecture 4 - Entropy change of a control volume - Part 3

Lecture 5 - Work interaction of internally reversible steady flow processes

Lecture 6 - Exergy - Part 1

Lecture 7 - Exergy - Part 2

Lecture 8 - Exergy - Part 3

Lecture 9 - Exergy - Part 4

Lecture 10 - Exergy - Part 5

Lecture 11 - Thermodynamic cycles - Rankine cycle - Part 1

Lecture 12 - Thermodynamic cycles - Rankine cycle - Part 2

Lecture 13 - Thermodynamic cycles - Rankine cycle - Part 3

Lecture 14 - Thermodynamic cycles - Air standard Brayton cycle - Part 1

Lecture 15 - Thermodynamic cycles - Air standard Brayton cycle - Part 2

Lecture 16 - Thermodynamic cycles - Air standard Brayton cycle - Part 3

Lecture 17 - Thermodynamic cycles - Air standard Brayton cycle - Part 4

Lecture 18 - Thermodynamic cycles - Air standard Brayton cycle - Part 5

Lecture 19 - Thermodynamic cycles - Air standard Otto cycle

Lecture 20 - Thermodynamic cycles - Air standard Diesel cycle - Part 1

Lecture 21 - Thermodynamic cycles - Air standard Diesel cycle - Part 2

Lecture 22 - Thermodynamic cycles - Vapor compression refrigeration cycle

Lecture 23 - Psychrometry - Part 1

Lecture 24 - Psychrometry - Part 2

Lecture 25 - Psychrometry - Part 3

Lecture 26 - Psychrometry - Part 4

Lecture 27 - Psychrometry - Part 5

Lecture 28 - Psychrometry - Part 6

Lecture 29 - Psychrometry - Part 7

Lecture 30 - Combustion thermodynamics - Part 1

Lecture 31 - Combustion thermodynamics - Part 2

[Lecture 32 - Combustion Thermodynamics - Part 3](#)

[Lecture 33 - Combustion thermodynamics - Part 4](#)

[Lecture 34 - Compressible flow through nozzles - Part 1](#)

[Lecture 35 - Compressible flow through nozzles - Part 2](#)

[Lecture 36 - Compressible flow through nozzles - Part 3](#)

[Lecture 37 - Compressible flow through nozzles - Part 4](#)

[Lecture 38 - Compressible flow through nozzles - Part 5](#)

[Lecture 39 - Compressible flow through nozzles - Part 6](#)

[Lecture 40 - Compressible flow through nozzles - Part 7](#)

[Lecture 41 - Compressible flow through nozzles - Part 8](#)

[Lecture 42 - Compressible flow through nozzles - Part 9](#)

[Lecture 43 - Compressible flow through nozzles - Part 10](#)

[Lecture 44 - Compressible flow through nozzles - Part 11](#)

[Lecture 45 - Compressible flow through nozzles - Part 12](#)

Lecture 1 - Introduction to Heat Transfer

Lecture 2 - Introduction to Heat Transfer - Practical examples

Lecture 3 - Introduction to Heat Transfer - Rate laws Conduction

Lecture 4 - Introduction to Heat Transfer - Rate laws Convection

Lecture 5 - Introduction to Heat Transfer - Rate laws Radiation

Lecture 6 - Radiation Heat Transfer

Lecture 7 - Radiation Laws

Lecture 8 - Universal Black Body Curve

Lecture 9 - Properties of Real Surfaces

Lecture 10 - Properties of Real Surfaces (Continued...)

Lecture 11 - Kirchoff's Law and example problems

Lecture 12 - Radiosity Irradiation Method and Viewfactors

Lecture 13 - Viewfactor Algebra

Lecture 14 - Conduction

Lecture 15 - Conduction: Steady state conduction equation

Lecture 16 - Conduction in composite wall

Lecture 17 - Conduction in cylinder

Lecture 18 - Critical Radius of Insulation

Lecture 19 - Conduction with heat generation

Lecture 20 - Variable Thermal Conductivity and example problems

Lecture 21 - Fin heat transfer

Lecture 22 - Fin heat transfer continued

Lecture 23 - Fin heat transfer continued

Lecture 24 - Unsteady Heat Conduction

Lecture 25 - Unsteady Heat Conduction (Continued...)

Lecture 26 - Lumped capacitance Method

Lecture 27 - Unsteady Heat Conduction (Continued...)

Lecture 28 - Method of Separation of variables

Lecture 29 - Conduction Analytical solution

Lecture 30 - Conduction Numerical solution

Lecture 31 - Introduction to convection

[Lecture 32 - Governing Equations for Convection](#)

[Lecture 33 - Energy equation](#)

[Lecture 34 - Convection - Boundary layer theory](#)

[Lecture 35 - Convection - Integral momentum equation](#)

[Lecture 36 - Solution to Integral Energy equation](#)

[Lecture 37 - Internal Flow - Flow inside pipes and ducts](#)

[Lecture 38 - Internal Flow - Turbulent heat transfer](#)

[Lecture 39 - Natural Convection](#)

[Lecture 40 - Heat Exchangers - 1](#)

[Lecture 41 - Heat Exchangers - 2](#)



Lecture 1 - Introduction to the Inverse Methods in Heat Transfer Course

Lecture 2 - Inverse Problems - Definition, History and Applications

Lecture 3 - The inverse problem solving process

Lecture 4 - Review of Basic Heat Transfer for this course

Lecture 5 - Introduction to Week - 2

Lecture 6 - Introduction to Linear Regression for Inverse Problems

Lecture 7 - Example Application of Linear regression for an inverse conduction problem

Lecture 8 - Goodness of Fit and Coefficient of Determination

Lecture 9 - Linear Regression with Quadratic Model

Lecture 10 - Summary of Week - 2

Lecture 11 - Introduction to Week - 3

Lecture 12 - Introduction to Normal Equations for linear models

Lecture 13 - Normal Equations for linear models (Continued...)

Lecture 14 - Parity Plots

Lecture 15 - Programming Inverse Methods using Normal Equations

Lecture 16 - Variants on the Linear Model for inverse problems

Lecture 17 - Summary of Week - 3

Lecture 18 - The General Inverse Methods Process

Lecture 19 - Simple nonlinear inverse problem - Transient Heat transfer

Lecture 20 - Review of required calculus results

Lecture 21 - Gradient Descent Algorithm

Lecture 22 - Gradient Descent - Simple Example

Lecture 23 - Gradient Descent for Nonlinear Inverse Problem - Theory

Lecture 24 - Gradient Descent for Nonlinear Inverse Problem - Coding Example

Lecture 25 - Newton Algorithm for a System of Equations

Lecture 26 - Gauss Newton Algorithm - Derivation and Code

Lecture 27 - Overfitting and Regularization for Linear Models

Lecture 28 - Tikhonov Regularization and Levenberg-Marquardt - Theory

Lecture 29 - Tikhonov and Levenberg-Marquardt - Example Code

Lecture 30 - Introduction to Probability for Inverse Methods

Lecture 31 - Sum and Product Rules of Probability

- Lecture 32 - Bayes Theorem - Simple Examples
- Lecture 33 - Independence and Expectation
- Lecture 34 - Variance and Covariance
- Lecture 35 - Gaussian distribution and the standard normal table
- Lecture 36 - Maximum Likelihood Estimate
- Lecture 37 - MLE, MAP estimates
- Lecture 38 - Introduction to Bayesian Methods for Inverse Problems
- Lecture 39 - Offline Bayesian Estimation
- Lecture 40 - Offline Bayesian Estimation - MATLAB Demo
- Lecture 41 - MHMCMC for Inverse Problems
- Lecture 42 - MHMCMC for Inverse Problems - MATLAB Demo
- Lecture 43 - Why Machine Learning in Inverse Heat Transfer ?
- Lecture 44 - Overview of AI and ML
- Lecture 45 - Supervised Machine Learning as an Inverse Problem
- Lecture 46 - Introduction to Week 9 - From Linear Models to Neural Networks
- Lecture 47 - Gradient Descent - Batch, Stochastic and Mini Batch
- Lecture 48 - Logistic Regression - The Forward Model
- Lecture 49 - Logistic Regression - Binary Entropy Cost Function and Gradient
- Lecture 50 - Multiclass Classification
- Lecture 51 - Linear Separability and Neural Networks
- Lecture 52 - Introduction to Week 10 - XOR and Deeper networks
- Lecture 53 - Forward pass through a simple neural network
- Lecture 54 - Backprop in a scalar chain
- Lecture 55 - Backprop in a MLP
- Lecture 56 - Introduction to Week 11 - ANNs as Surrogate models
- Lecture 57 - Physics Informed Neural Networks - Introduction
- Lecture 58 - Physics Informed Neural Networks - an intuitive explanation
- Lecture 59 - Physics Informed Neural Networks - BC incorporation
- Lecture 60 - PINNs for inverse problems
- Lecture 61 - Introduction to Week 12 - Sensitivity Analysis
- Lecture 62 - Code Examples of Logistic Regression - OR and AND gates
- Lecture 63 - Code Example of shallow neural network - XOR gate
- Lecture 64 - Code walkthrough for PINNs in Burgers equation

[Lecture 65 - Formulation of a PINN based inverse problem in unsteady conduction](#)

[Lecture 66 - Formulation of a surrogate model based inverse solution in unsteady conduction](#)

[Lecture 67 - Summary of course](#)

Lecture 1 - Introduction and Fundamental Concepts - Part 1

Lecture 2 - Introduction and Fundamental Concepts - Part 2

Lecture 3 - Energy Scenario in Modern World - Part 1

Lecture 4 - Energy Scenario in Modern World - Part 2

Lecture 5 - Macro Trends in Energy Use - World and India - Part 1

Lecture 6 - Macro Trends in Energy Use - World and India - Part 2

Lecture 7 - Impact of Fossil fuels - Part 1

Lecture 8 - Impact of Fossil fuels - Part 2

Lecture 9 - Fossil Fuels and Climate Change - Part 1

Lecture 10 - Fossil Fuels and Climate Change - Part 2

Lecture 11 - Continual of previous lecture and Overview of Renewable energy Technology - Part 1

Lecture 12 - Continual of previous lecture and Overview of Renewable energy Technology - Part 2

Lecture 13 - Numerical examples - Part 1

Lecture 14 - Numerical examples - Part 2

Lecture 15 - Renewable Energy Contributions - Part 1

Lecture 16 - Renewable Energy Contributions - Part 2

Lecture 17 - Hydro Power - Part 1

Lecture 18 - Hydro Power - Part 2

Lecture 19 - The Fundamentals of various Turbine working principle - Part 1

Lecture 20 - The Fundamentals of various Turbine working principle - Part 2

Lecture 21 - Hydroturbine Selection Principle

Lecture 22 - Pumped Hydro Storage

Lecture 23 - Worked Out Examples of HydroPower

Lecture 24 - Introduction to Wind Energy - Part 1

Lecture 25 - Introduction to Wind Energy - Part 2

Lecture 26 - Wind Speed and Power Analysis - Part 1

Lecture 27 - Wind Speed and Power Analysis - Part 2

Lecture 28 - Design of Wind Turbine - Part 1

Lecture 29 - Design of Wind Turbine - Part 2

Lecture 30 - Wind Turbine Parts and Performance - Part 1

Lecture 31 - Wind Turbine Parts and Performance - Part 2

[Lecture 32 - Wind farms, Offshore Wind Turbines and Numerical Examples in Wind Energy - Part 1](#)

[Lecture 33 - Wind farms, Offshore Wind Turbines and Numerical Examples in Wind Energy - Part 2](#)

[Lecture 34 - Introduction to Solar Energy - Part 1](#)

[Lecture 35 - Introduction to Solar Energy - Part 2](#)

[Lecture 36 - Solar Thermal Energy Systems - Part 1](#)

[Lecture 37 - Solar Thermal Energy Systems - Part 2](#)

[Lecture 38 - Solar Water Heaters - Part 1](#)

[Lecture 39 - Solar Water Heaters - Part 2](#)

[Lecture 40 - Concentrated Solar Thermal Power \(CSP\)](#)

[Lecture 41 - Introduction to Solar Photovoltaic Systems - Part 1](#)

[Lecture 42 - Introduction to Solar Photovoltaic Systems - Part 2](#)

[Lecture 43 - Solar Photovoltaic Technology - Part 1](#)

[Lecture 44 - Solar Photovoltaic Technology - Part 2](#)

[Lecture 45 - Doping of a Semiconductor - Part 1](#)

[Lecture 46 - Doping of a Semiconductor - Part 2](#)

[Lecture 47 - Structure of a Solar Cell and its Electrical Properties - Part 1](#)

[Lecture 48 - Structure of a Solar Cell and its Electrical Properties - Part 2](#)

[Lecture 49 - Solar Cell Efficiency - Part 1](#)

[Lecture 50 - Solar Cell Efficiency - Part 2](#)

[Lecture 51 - Types of solar cells - Part 1](#)

[Lecture 52 - Types of solar cells - Part 2](#)

[Lecture 53 - Bioenergy and Biofuels - Part 1](#)

[Lecture 54 - Bioenergy and Biofuels - Part 2](#)

[Lecture 55 - Biofuel Feedstocks](#)

[Lecture 56 - Bioenergy Technology and Sustainability - Part 1](#)

[Lecture 57 - Bioenergy Technology and Sustainability - Part 2](#)

[Lecture 58 - Production Technologies for Bioethanol, Biodiesel and Biogas](#)

[Lecture 59 - Introduction of Geothermal Energy](#)

[Lecture 60 - Different types of Geothermal power systems](#)

[Lecture 61 - Characteristics of electricity demand and the technology is developed to respond the energy demand](#)

[Lecture 62 - Continuation of Energy demand and adaptation of renewable energies](#)

[Lecture 63 - Introduction of Energy storage system](#)

[Lecture 64 - Major parameters of energy storage technology](#)

[Lecture 65 - Mechanical Energy Storage Technologies](#)

[Lecture 66 - Compressed Air Energy Storage System](#)

[Lecture 67 - Flywheel Based Energy Storage System - Part 1](#)

[Lecture 68 - Flywheel Based Energy Storage System - Part 2](#)

[Lecture 69 - Energy Storage System Through Capacitor](#)

[Lecture 70 - Electrolytic Capacitor](#)

[Lecture 71 - Super Capacitor](#)

[Lecture 72 - Electrochemical Energy Storage Systems](#)

[Lecture 73 - Performance Characteristics of Battery](#)

[Lecture 74 - Types of Rechargeable Batteries - Part 1](#)

[Lecture 75 - Types of Rechargeable Batteries - Part 2](#)

[Lecture 76 - Thermal Energy Storage Systems - Part 1](#)

[Lecture 77 - Thermal Energy Storage Systems - Part 2](#)

[Lecture 78 - Storage of Coolness and Synoptic View of Energy Storage Technology](#)

[Lecture 79 - Storage Needs for the Grid](#)

[Lecture 80 - Energy Storage Types](#)

[Lecture 81 - Trends in Energy Storage Types and their Characteristics](#)

[Lecture 82 - Analysis of Growth in Energy Storage-focussed on Pumped Hydro Storage, Flywheels and Li-ion batteries](#)

[Lecture 83 - Fuel Cells and Hydrogen Energy Economy](#)

[Lecture 84 - Hydrogen production and storage technologies](#)

[Lecture 85 - Hydrogen storage technologies](#)

[Lecture 86 - Fuel cell technology](#)

[Lecture 87 - Fuel cell types](#)

[Lecture 88 - Carbon Capture and Storage \(CCS\) technologies - Part 1](#)

[Lecture 89 - Carbon Capture and Storage \(CCS\) technologies - Part 2](#)

- Lecture 1 - Introduction to Strength of Materials - 1
- Lecture 2 - Introduction to Strength of Materials - 2
- Lecture 3 - Stress Component is Scalar
- Lecture 4 - Stress Vector
- Lecture 5 - Stress Tensor
- Lecture 6 - Equilibrium Conditions
- Lecture 7 - Mohr's Circle
- Lecture 8 - Proof of Mohr's Circle
- Lecture 9 - Principal Stresses
- Lecture 10 - Octahedral and Deviatoric Stresses and Principal Directions
- Lecture 11 - Free Surfaces
- Lecture 12 - Photoelasticity
- Lecture 13 - Strain
- Lecture 14 - State of Strain
- Lecture 15 - Strain Measurement
- Lecture 16 - Tension Test
- Lecture 17 - Stress Strain Relations
- Lecture 18 - Interrelations between Elastic Constants
- Lecture 19 - Thermal Strain
- Lecture 20 - Torsion 1 - Thought and Physical Experiments
- Lecture 21 - Torsion 2 - Mathematical Development
- Lecture 22 - Torsion 3 - Problem solving, Hollow shaft
- Lecture 23 - Bending 1 - Euler-Bernoulli Hypothesis
- Lecture 24 - Bending 2 - Flexure Formula
- Lecture 25 - Bending 3 - Engineering Analysis of Beams
- Lecture 26 - Bending 4 - Shear Stress in Beams
- Lecture 27 - Bending 5 - Composite Beams
- Lecture 28 - Bending 6 - Shear in I Beams and Shear Centre
- Lecture 29 - Bending 7 - Unsymmetrical Bending and Combined Loading
- Lecture 30 - Review 1
- Lecture 31 - Deflection 1 - Moment-Curvature and Load Deflection

[Lecture 32 - Deflection 2 - Moment-Area Method](#)

[Lecture 33 - Deflection 3 - Method of Superposition and Energy Method](#)

[Lecture 34 - Deflection 4 - Fictitious Load Method](#)

[Lecture 35 - Theories of Failure 1 - Overview](#)

[Lecture 36 - Theories of Failure 2 - Yield surfaces, Mohr's Theory and Failure in Combined Loading](#)

[Lecture 37 - Stability 1 - Governing Equations, Fixed-free and Pinned-pinned](#)

[Lecture 38 - Stability 2 - Fixed-pinned, Fixed-fixed](#)

[Lecture 39 - Review 2](#)



Lecture 1 - Course outline

Lecture 2 - Introduction - Part 1

Lecture 3 - Introduction - Part 2

Lecture 4 - Basic concepts - Part 1

Lecture 5 - Basic concepts - Part 2

Lecture 6 - Basic concepts - Part 3

Lecture 7 - Basic concepts - Part 4

Lecture 8 - Basic concepts - Part 5

Lecture 9 - Tutorial 1 - Basic concepts, pressure and temperature measurements - Part 1

Lecture 10 - Tutorial 1 - Basic concepts, pressure and temperature measurements - Part 2

Lecture 11 - Tutorial 1 - Basic concepts, pressure and temperature measurements - Part 3

Lecture 12 - Work and Heat - Part 1

Lecture 13 - Work and Heat - Part 2

Lecture 14 - Work and Heat - Part 3

Lecture 15 - Tutorial 2 - Work and heat transfer examples - Part 1

Lecture 16 - Tutorial 2 - Work and heat transfer examples - Part 2

Lecture 17 - Tutorial 2 - Work and heat transfer examples - Part 3

Lecture 18 - First law of thermodynamics

Lecture 19 - Pure substances

Lecture 20 - Ideal gases and ideal gas mixtures

Lecture 21 - Two-phase mixtures - Part 1

Lecture 22 - Two-phase mixtures - Part 2

Lecture 23 - First law analysis of systems - Part 1

Lecture 24 - First law analysis of systems - Part 2

Lecture 25 - First law analysis of systems - Part 3

Lecture 26 - First law analysis of systems - Part 4

Lecture 27 - Tutorial 3 - First law analysis of system - Part 1

Lecture 28 - Tutorial 3 - First law analysis of system - Part 2

Lecture 29 - Tutorial 3 - First law analysis of system - Part 3

Lecture 30 - Tutorial 4 - Systems involving ideal gas mixtures - Part 1

Lecture 31 - Tutorial 4 - Systems involving ideal gas mixtures - Part 2

[Lecture 32 - Tutorial 4 - Systems involving ideal gas mixtures - Part 3](#)

[Lecture 33 - Tutorial 5 - Systems involving Steam and R134a using table - Part 1](#)

[Lecture 34 - Tutorial 5 - Systems involving Steam and R134a using table - Part 2](#)

[Lecture 35 - Tutorial 5 - Systems involving Steam and R134a using table - Part 3](#)

[Lecture 36 - Tutorial 5 - Systems involving Steam and R134a using table - Part 4](#)

[Lecture 37 - Tutorial 5 - Systems involving Steam and R134a using table - Part 5](#)

[Lecture 38 - Tutorial 5 - Systems involving Steam and R134a using table - Part 6](#)

[Lecture 39 - First law of thermodynamics for a control volume](#)

[Lecture 40 - Control volume analysis of steady flow devices - Part 1](#)

[Lecture 41 - Control volume analysis of steady flow devices - Part 2](#)

[Lecture 42 - Control volume analysis of steady flow devices - Part 3](#)

[Lecture 43 - Unsteady analysis](#)

[Lecture 44 - Tutorial 6 - First law for control volumes](#)

[Lecture 45 - Second law of Thermodynamics - Part 1](#)

[Lecture 46 - Second law of Thermodynamics - Part 2](#)

[Lecture 47 - Second law of Thermodynamics - Part 3](#)

[Lecture 48 - Second law of Thermodynamics - Part 4](#)

[Lecture 49 - Second law of Thermodynamics - Part 5](#)

[Lecture 50 - Tutorial 7 - Second law of thermodynamics - Part 1](#)

[Lecture 51 - Tutorial 7 - Second law of thermodynamics - Part 2](#)

[Lecture 52 - Tutorial 7 - Second law of thermodynamics - Part 3](#)

[Lecture 53 - Tutorial 7 - Second law of thermodynamics - Part 4](#)

[Lecture 54 - Tutorial 7 - Second law of thermodynamics - Part 5](#)

[Lecture 55 - Entropy - Part 1](#)

[Lecture 56 - Entropy - Part 2](#)

[Lecture 57 - Entropy - Part 3](#)

[Lecture 58 - Entropy - Part 4](#)

[Lecture 59 - Entropy - Part 5](#)

[Lecture 60 - Entropy - Part 6](#)

[Lecture 61 - Tutorial 8 - Entropy - Part 1](#)

[Lecture 62 - Tutorial 8 - Entropy - Part 2](#)

[Lecture 63 - Tutorial 8 - Entropy - Part 3](#)

[Lecture 64 - Tutorial 8 - Entropy - Part 4](#)

[Lecture 65 - Tutorial 8 - Entropy - Part 5](#)

[Lecture 66 - Thermodynamic cycles - Part 1](#)

[Lecture 67 - Thermodynamic cycles - Part 2](#)

[Lecture 68 - Tutorial 9 - Thermodynamic cycles - Part 1](#)

[Lecture 69 - Tutorial 9 - Thermodynamic cycles - Part 2](#)

[Lecture 70 - Tutorial 9 - Thermodynamic cycles - Part 3](#)

[Lecture 1 - Basics of Fire - Part 1](#)

[Lecture 2 - Basics of Fire - Part 2](#)

[Lecture 3 - Basics of Fire - Part 3](#)

[Lecture 4 - Basics of Fire - Part 4](#)

[Lecture 5 - Basics of Fire - Part 5](#)

[Lecture 6 - Basics of Fire - Part 6](#)

[Lecture 7 - Basics of Fire - Part 7](#)

[Lecture 8 - Basics of Fire - Part 8](#)

[Lecture 9 - Basics of Fire - Part 9](#)

[Lecture 10 - Review of thermo-chemistry, chemical equilibrium and kinetics - Part 1](#)

[Lecture 11 - Review of thermo-chemistry, chemical equilibrium and kinetics - Part 2](#)

[Lecture 12 - Review of thermo-chemistry, chemical equilibrium and kinetics - Part 3](#)

[Lecture 13 - Review of thermo-chemistry, chemical equilibrium and kinetics - Part 4](#)

[Lecture 14 - Review of thermo-chemistry, chemical equilibrium and kinetics - Part 5](#)

[Lecture 15 - Review of thermo-chemistry, chemical equilibrium and kinetics - Part 6](#)

[Lecture 16 - Review of thermo-chemistry, chemical equilibrium and kinetics - Part 7](#)

[Lecture 17 - Review of thermo-chemistry, chemical equilibrium and kinetics - Part 8](#)

[Lecture 18 - Review of Premixed and Diffusion Flames - Part 1](#)

[Lecture 19 - Review of Premixed and Diffusion Flames - Part 2](#)

[Lecture 20 - Review of Premixed and Diffusion Flames - Part 3](#)

[Lecture 21 - Review of Premixed and Diffusion Flames - Part 4](#)

[Lecture 22 - Review of Premixed and Diffusion Flames - Part 5](#)

[Lecture 23 - Review of Premixed and Diffusion Flames - Part 6](#)

[Lecture 24 - Review of Premixed and Diffusion Flames - Part 7](#)

[Lecture 25 - Review of Premixed and Diffusion Flames - Part 8](#)

[Lecture 26 - Burning of Liquid Fuels- Part 1](#)

[Lecture 27 - Burning of Liquid Fuels- Part 2](#)

[Lecture 28 - Burning of Liquid Fuels- Part 3](#)

[Lecture 29 - Burning of Liquid Fuels- Part 4](#)

[Lecture 30 - Burning of Liquid Fuels- Part 5](#)

[Lecture 31 - Burning of Liquid Fuels- Part 6](#)

[Lecture 32 - Burning of Liquid Fuels- Part 7](#)

[Lecture 33 - Burning of Liquid Fuels- Part 8](#)

[Lecture 34 - Burning of Solid Fuels - Part 1](#)

[Lecture 35 - Burning of Solid Fuels - Part 2](#)

[Lecture 36 - Burning of Solid Fuels - Part 3](#)

[Lecture 37 - Burning of Solid Fuels - Part 4](#)

[Lecture 38 - Burning of Solid Fuels - Part 5](#)

[Lecture 39 - Burning of Solid Fuels - Part 6](#)

[Lecture 40 - Burning of Solid Fuels - Part 7](#)

[Lecture 41 - Analysis of Fire Plumes - Part 1](#)

[Lecture 42 - Analysis of Fire Plumes - Part 2](#)

[Lecture 43 - Analysis of Fire Plumes - Part 3](#)

[Lecture 44 - Analysis of Fire Plumes - Part 4](#)

[Lecture 45 - Analysis of Fire Plumes - Part 5](#)

[Lecture 46 - Analysis of Fire Plumes - Part 6](#)

[Lecture 47 - Enclosure Fires - Part 1](#)

[Lecture 48 - Enclosure Fires - Part 2](#)

[Lecture 49 - Enclosure Fires - Part 3](#)

[Lecture 50 - Enclosure Fires - Part 4](#)

[Lecture 51 - Enclosure Fires - Part 5](#)

[Lecture 52 - Enclosure Fires - Part 6](#)

[Lecture 53 - Enclosure Fires - Part 7](#)

[Lecture 54 - Introduction to dust ignition, dust explosion and forest fires - Part 1](#)

[Lecture 55 - Introduction to dust ignition, dust explosion and forest fires - Part 2](#)

[Lecture 56 - Introduction to dust ignition, dust explosion and forest fires - Part 3](#)

[Lecture 57 - Introduction to dust ignition, dust explosion and forest fires - Part 4](#)

[Lecture 58 - Introduction to dust ignition, dust explosion and forest fires - Part 5](#)

[Lecture 59 - Fire safety aspects - Part 1](#)

[Lecture 60 - Fire safety aspects - Part 2](#)

[Lecture 61 - Fire safety aspects - Part 3](#)

[Lecture 1 - Data-driven models for unsteady fluid flows: Course overview](#)

[Lecture 2 - Data generation techniques for fluid flows](#)

[Lecture 3 - Dimensionality reduction of fluid flows](#)

[Lecture 4 - Reduced-order modeling of fluid flows](#)

[Lecture 5 - Turbulence modeling](#)

Lecture 1 - Introduction

Lecture 2 - Entropy change of a control volume - Part 1

Lecture 3 - Entropy change of a control volume - Part 2

Lecture 4 - Entropy change of a control volume - Part 3

Lecture 5 - Work interaction of internally reversible steady flow processes

Lecture 6 - Tutorial 1 - Entropy change of a control volume - Part 1

Lecture 7 - Tutorial 1 - Entropy change of a control volume - Part 2

Lecture 8 - Tutorial 2 - Entropy change of a control volume - Part 3

Lecture 9 - Tutorial 2 - Entropy change of a control volume - Part 4

Lecture 10 - Tutorial 2 - Entropy change of a control volume - Part 5

Lecture 11 - Tutorial 3 - Entropy change of a control volume, Work interaction of internally reversible - Part 1

Lecture 12 - Tutorial 3 - Entropy change of a control volume, Work interaction of internally reversible - Part 2

Lecture 13 - Tutorial 3 - Entropy change of a control volume, Work interaction of internally reversible - Part 3

Lecture 14 - Exergy - Part 1

Lecture 15 - Exergy - Part 2

Lecture 16 - Exergy - Part 3

Lecture 17 - Exergy - Part 4

Lecture 18 - Exergy - Part 5

Lecture 19 - Tutorial 4 - Exergy transfer and exergy change of a system - Part 1

Lecture 20 - Tutorial 4 - Exergy transfer and exergy change of a system - Part 2

Lecture 21 - Tutorial 5 - Exergy transfer and exergy change of a system - Part 3

Lecture 22 - Tutorial 5 - Exergy transfer and exergy change of a system - Part 4

Lecture 23 - Tutorial 5 - Exergy transfer and exergy change of a system - Part 5

Lecture 24 - Tutorial 6 - Exergy transfer and exergy change of a control volume - Part 1

Lecture 25 - Tutorial 6 - Exergy transfer and exergy change of a control volume - Part 2

Lecture 26 - Tutorial 6 - Exergy transfer and exergy change of a control volume - Part 3

Lecture 27 - Thermodynamic cycles - Rankine cycle - Part 1

Lecture 28 - Thermodynamic cycles - Rankine cycle - Part 2

Lecture 29 - Thermodynamic cycles - Rankine cycle - Part 3

Lecture 30 - Thermodynamic cycles - Air standard Brayton cycle - Part 1

Lecture 31 - Thermodynamic cycles - Air standard Brayton cycle - Part 2

[Lecture 32 - Thermodynamic cycles - Air standard Brayton cycle - Part 3](#)

[Lecture 33 - Thermodynamic cycles - Air standard Brayton cycle - Part 4](#)

[Lecture 34 - Thermodynamic cycles - Air standard Brayton cycle - Part 5](#)

[Lecture 35 - Thermodynamic cycles - Air standard Otto cycle](#)

[Lecture 36 - Thermodynamic cycles - Air standard Diesel cycle - Part 1](#)

[Lecture 37 - Thermodynamic cycles - Air standard Diesel cycle - Part 2](#)

[Lecture 38 - Thermodynamic cycles - Vapor compression refrigeration cycle](#)

[Lecture 39 - Psychrometry - Part 1](#)

[Lecture 40 - Psychrometry - Part 2](#)

[Lecture 41 - Psychrometry - Part 3](#)

[Lecture 42 - Psychrometry - Part 4](#)

[Lecture 43 - Psychrometry - Part 5](#)

[Lecture 44 - Psychrometry - Part 6](#)

[Lecture 45 - Psychrometry - Part 7](#)

[Lecture 46 - Tutorial 7 - Psychrometry and Air conditioning processes - Part 1](#)

[Lecture 47 - Tutorial 7 - Psychrometry and Air conditioning processes - Part 2](#)

[Lecture 48 - Tutorial 8 - Psychrometry and Air conditioning processes - Part 3](#)

[Lecture 49 - Tutorial 8 - Psychrometry and Air conditioning processes - Part 4](#)

[Lecture 50 - Combustion Thermodynamics - Part 1](#)

[Lecture 51 - Combustion Thermodynamics - Part 2](#)

[Lecture 52 - Combustion Thermodynamics - Part 3](#)

[Lecture 53 - Combustion Thermodynamics - Part 4](#)

[Lecture 54 - Tutorial 9 - Stoichiometry - Part 1](#)

[Lecture 55 - Tutorial 9 - Stoichiometry - Part 2](#)

[Lecture 56 - Tutorial 10 - Heat and temperature calculations in combustion - Part 1](#)

[Lecture 57 - Tutorial 10 - Heat and temperature calculations in combustion - Part 2](#)

[Lecture 58 - Tutorial 10 - Heat and temperature calculations in combustion - Part 3](#)

[Lecture 59 - Tutorial 10 - Heat and temperature calculations in combustion - Part 4](#)

[Lecture 60 - Tutorial 10 - Heat and temperature calculations in combustion - Part 5](#)

[Lecture 61 - Compressible flow through nozzles - Part 1](#)

[Lecture 62 - Compressible flow through nozzles - Part 2](#)

[Lecture 63 - Compressible flow through nozzles - Part 3](#)

[Lecture 64 - Compressible flow through nozzles - Part 4](#)



[Lecture 65 - Compressible flow through nozzles - Part 5](#)

[Lecture 66 - Compressible flow through nozzles - Part 6](#)

[Lecture 67 - Compressible flow through nozzles - Part 7](#)

[Lecture 68 - Compressible flow through nozzles - Part 8](#)

[Lecture 69 - Compressible flow through nozzles - Part 9](#)

[Lecture 70 - Compressible flow through nozzles - Part 10](#)

[Lecture 71 - Compressible flow through nozzles - Part 11](#)

[Lecture 72 - Compressible flow through nozzles - Part 12](#)

Lecture 1 - Course Introduction, Evaluation, and Application of Gearbox

Lecture 2 - Machine Tool Gearbox: GP, Step Ratio, Preferred Numbers, Structural Formula and Rules of Optimum Gearbox

Lecture 3 - Machine Tool Gearbox: Ray Diagram Construction

Lecture 4 - Machine Tool Gearbox: Kinematic Diagram Construction

Lecture 5 - Machine Tool Gearbox: Centre Distance and Teeth Calculation

Lecture 6 - Machine Tool Gearbox: Problem Solving

Lecture 7 - Automobile Gearbox: General Engine Operation and Transmission Types

Lecture 8 - Automobile Gearbox: Saw Tooth Diagram and Design Procedure for Gearbox

Lecture 9 - Automobile Gearbox: Problem Solving and Tyre Specification

Lecture 10 - Automobile Gearbox: Basic Transmission Types and Kinematic Diagram

Lecture 11 - Automobile Gearbox: Gear Failures and Material Selection

Lecture 12 - Automobile Gearbox: Module Calculation Concept - Part I

Lecture 13 - Automobile Gearbox: Module Calculation Concept - Part II

Lecture 14 - Automobile Gearbox: Shaft Design, Lubrication Selection and Method

Lecture 15 - Automobile Gearbox: Bearing Selection and Gearbox Losses

Lecture 16 - Brake: Introduction, Working Principle and Types

Lecture 17 - Brake: Torque Requirement for Drum Brake Systems

Lecture 18 - Brake: Problem Solving

Lecture 19 - Brake: Torque Requirement for Disc Brake Systems

Lecture 20 - Brake: Static and Dynamic Analysis

Lecture 21 - Brake: Dynamic Analysis - Brake Force Distribution and Optimum

Lecture 22 - Brake: Problem Solving

Lecture 23 - Brake: Braking Efficiency and Distance and Brake Factor

Lecture 24 - Brake: Problem Solving and Friction Materials

Lecture 25 - Brake: Thermal Analysis and Braking Conditions

Lecture 26 - Brake: Energy and Power, Braking Power Absorbed by Lining and Drum/Disc

Lecture 27 - Brake: Single Stop Braking and Repeated Braking - Temperature Analysis

Lecture 28 - Brake: Thermal Analysis Problem Solving

Lecture 29 - Clutch: Types and Working Method

Lecture 30 - Clutch: Torque Transmitting Capacity - Uniform Pressure and Wear Theories

Lecture 31 - Clutch: Multiple Discs and Cone Clutches, Problem Solving

[Lecture 32 - Clutch: Centrifugal Clutch](#)

[Lecture 33 - Clutch: Dynamic Analysis](#)

[Lecture 34 - Clutch: Dynamic Analysis Problem Solving](#)

**NPTEL : NOC:Turbulence Modeling (Mechanical Engineering)**

**Co-ordinators : Prof. Vagesh D. Narasimhamurthy**

Lecture 1 - Introduction to turbulence

Lecture 2 - Statistical Analysis: An approach of modelling turbulence - I

Lecture 3 - Statistical Analysis: An approach of modelling turbulence - II

Lecture 4 - Statistical Analysis and Cartesian tensors - I

Lecture 5 - Statistical Analysis and Cartesian tensors - II

Lecture 6 - Navier Stokes: the governing equations - 1

Lecture 7 - Navier Stokes: the governing equations - 2

Lecture 8 - RANS equations I - 1

Lecture 9 - RANS equations I - 2

Lecture 10 - RANS equations II - 1

Lecture 11 - RANS equations II - 2

Lecture 12 - Reynold's stress: governing equations - I

Lecture 13 - Reynold's stress: governing equations - II

Lecture 14 - Statistical Stationarity and Homogeneity in Plane Couette Flows - I

Lecture 15 - Statistical Stationarity and Homogeneity in Plane Couette Flows - II

Lecture 16 - Pressure-strain-rate and redistribution of turbulence in flows - I

Lecture 17 - Pressure-strain-rate and redistribution of turbulence in flows - II

Lecture 18 - Turbulence Kinetic Energy and it's dissipation rate - I

Lecture 19 - Turbulence Kinetic Energy and it's dissipation rate - II

Lecture 20 - Production rate of TKE and Mean TKE - I

Lecture 21 - Production rate of TKE and Mean TKE - II

Lecture 22 - Turbulent Boundary Layer: Order of Magnitude analysis - I

Lecture 23 - Turbulent Boundary Layer: Order of Magnitude analysis - II

Lecture 24 - Inner and Outer TBL: Order of magnitude analysis - I

Lecture 25 - Inner and Outer TBL: Order of magnitude analysis - II

Lecture 26 - Inner layer equation, constant stress layer, and inner velocity scaling - I

Lecture 27 - Inner layer equation, constant stress layer, and inner velocity scaling - II

Lecture 28 - Reynold's Averaged Navier-Stokes (RANS) models - I

Lecture 29 - Reynold's Averaged Navier-Stokes (RANS) models - II

Lecture 30 - Different approaches to solve turbulence closure problem - I

Lecture 31 - Different approaches to solve turbulence closure problem - II

[Lecture 32 - Modelling of turbulent kinetic energy \(k\): production, destruction, and dissipation rate - I](#)

[Lecture 33 - Modelling of turbulent kinetic energy \(k\): production, destruction, and dissipation rate - II](#)

[Lecture 34 - Standard k- \$\epsilon\$  model and the model constants - I](#)

[Lecture 35 - Standard k- \$\epsilon\$  model and the model constants - II](#)

[Lecture 36 - Standard k- \$\epsilon\$  model, RNG k- \$\epsilon\$  model, and Prandtl's one equation model - I](#)

[Lecture 37 - Standard k- \$\epsilon\$  model, RNG k- \$\epsilon\$  model, and Prandtl's one equation model - II](#)

[Lecture 38 - New model k- \$\epsilon\$  and model constants - I](#)

[Lecture 39 - New model k- \$\epsilon\$  and model constants - II](#)

[Lecture 40 - Introduction to wall-functions - I](#)

[Lecture 41 - Introduction to wall-functions - II](#)

[Lecture 42 - Introduction to wall-resolved simulations - I](#)

[Lecture 43 - Introduction to wall-resolved simulations - II](#)

[Lecture 44 - Damping functions for LRN - I](#)

[Lecture 45 - Damping functions for LRN - II](#)

[Lecture 46 - Boundary and Initial conditions for RANS simulations - I](#)

[Lecture 47 - Boundary and Initial conditions for RANS simulations - II](#)

[Lecture 48 - Realizability constraints in eddy-viscosity models - I](#)

[Lecture 49 - Realizability constraints in eddy-viscosity models - II](#)

[Lecture 50 - Correctors for eddy-viscosity models - I](#)

[Lecture 51 - Correctors for eddy-viscosity models - II](#)

[Lecture 52 - Reynolds Stress Modelling \(RSM\): governing equations - I](#)

[Lecture 53 - Reynolds Stress Modelling \(RSM\): governing equations - II](#)

[Lecture 54 - Dissipation rate and Pressure-Strain rate modelling for RSM - I](#)

[Lecture 55 - Dissipation rate and Pressure-Strain rate modelling for RSM - II](#)

[Lecture 56 - Pressure-Strain rate modelling for RSM - I](#)

[Lecture 57 - Pressure-Strain rate modelling for RSM - II](#)

[Lecture 58 - Pressure-Strain rate modelling and wall corrections for RSM - I](#)

[Lecture 59 - Pressure-Strain rate modelling and wall corrections for RSM - II](#)

[Lecture 60 - Introduction to Eddy Resolved Models - I](#)

[Lecture 61 - Introduction to Eddy Resolved Models - II](#)

[Lecture 62 - Introduction to Direct Numerical Simulations \(DNS\) - I](#)

[Lecture 63 - Introduction to Direct Numerical Simulations \(DNS\) - II](#)

[Lecture 64 - Introduction to Large Eddy Simulations \(LES\) Filtering operation and SGS stresses - I](#)

[Lecture 65 - Introduction to Large Eddy Simulations \(LES\) Filtering operation and SGS stresses - II](#)

[Lecture 66 - Large Eddy Simulations: Filtered Navier-Stokes Equations - I](#)

[Lecture 67 - Large Eddy Simulations: Filtered Navier-Stokes Equations - II](#)

[Lecture 68 - Large Eddy Simulations: Filters and its types - I](#)

[Lecture 69 - Large Eddy Simulations: Filters and its types - II](#)

[Lecture 70 - Large Eddy Simulations: Smagorinsky model - I](#)

[Lecture 71 - Large Eddy Simulations: Smagorinsky model - II](#)

[Lecture 72 - LES: Dynamic Smagorinsky model and Scale similarity models - I](#)

[Lecture 73 - LES: Dynamic Smagorinsky model and Scale similarity models - II](#)

[Lecture 74 - Numerics in LES and Hybrid models](#)

- Lecture 1 - Manufacturing and Manufacturing Systems
- Lecture 2 - Manufacturing Trends and Challenges
- Lecture 3 - Manufacturing Aspects, Selection and Classification
- Lecture 4 - Description and Taxonomy of the Mfg. Processes
- Lecture 5 - Metal Casting basics, Gating and Riser design
- Lecture 6 - Evaporative Pattern Casting Process (EPC)
- Lecture 7 - Continuous, Permanent mold, Centrifugal and Pressure Die Casting
- Lecture 8 - Hybrid EPC Processes and Vacuum EPC Process
- Lecture 9 - Set-up of VEPC and Investment Casting Processes
- Lecture 10 - Ceramic Shell Investment Casting Process
- Lecture 11 - Shell Molding Process
- Lecture 12 - Abrasive Flow Machining
- Lecture 13 - Mechanism of Material Removal in AFM and Variant processes in AFM
- Lecture 14 - Abrasive Jet Machining (AJM)
- Lecture 15 - Water Jet and Abrasive Water Jet Machining
- Lecture 16 - Ultrasonic Machining Process (USM)
- Lecture 17 - Mechanism, Processes Variants and applications of USM
- Lecture 18 - Micro USM and advances in USM
- Lecture 19 - Electric Discharge Machining (EDM) Process
- Lecture 20 - Die-Sinker EDM and Wire Cut Electric Discharge Machining (WEDM)
- Lecture 21 - Variant Processes in EDM
- Lecture 22 - Electro Chemical Discharge Machining (ECDM)
- Lecture 23 - Laser Beam Machining (LBM)
- Lecture 24 - Equipment and Process Parameters in LBM
- Lecture 25 - Electrochemical Machining (ECM)
- Lecture 26 - ECM Kinematics and Tool Design
- Lecture 27 - The Subsystems in ECM, advantages and applications
- Lecture 28 - Variant Processes in ECM: ECG, ECH, ECDe and STEM
- Lecture 29 - Electron Beam, Plasma Beam and Ion Beam Machining
- Lecture 30 - Submerged Arc Welding (SAW)
- Lecture 31 - Resistance Welding Process

[Lecture 32 - Solid State Welding processes](#)

[Lecture 33 - Friction Welding process](#)

[Lecture 34 - Electron Beam and Plasma Welding Processes](#)

[Lecture 35 - Laser Beam welding and Diffusion welding processes](#)

[Lecture 36 - High Energy Rate Forming Processes](#)

[Lecture 37 - Rapid Prototyping Technology \(RPT\)](#)

[Lecture 38 - Rapid Manufacturing, applications and advancements](#)

[Lecture 39 - Microwave Processing of Materials](#)

[Lecture 40 - Applications and new trends in Microwave Material Processing](#)



- Lecture 1 - General Introduction: Historical Background and Spectrum of Applications
- Lecture 2 - CFD: Simulation Process and Course Outline
- Lecture 3 - Conservation Laws and Mathematical Preliminaries
- Lecture 4 - Mass Conservation: Continuity Equation
- Lecture 5 - Momentum Equation: Newton's 2nd Law
- Lecture 6 - Momentum Equation: Navier-Stokes Equations
- Lecture 7 - Navier-Stokes Equation and its Simplified Forms
- Lecture 8 - Energy and Scalar Transport Equations
- Lecture 9 - Scalar Transport, Mathematical Classification and Boundary Conditions
- Lecture 10 - Finite Difference Method: Methodology and Grid Notation
- Lecture 11 - Finite Difference Approximation of First Order Derivatives
- Lecture 12 - Finite Difference Approximation of Second Order Derivatives - 1
- Lecture 13 - Finite Difference Approximation of Second Order Derivatives - 2
- Lecture 14 - Approximation of Mixed Derivatives and Multi-Dimensional F.D. Formulae
- Lecture 15 - Implementation of Boundary Conditions and Finite Difference Algebraic System
- Lecture 16 - Applications of FDM to Scalar Transport Problems - 1
- Lecture 17 - Applications of FDM to Scalar Transport Problems - 2
- Lecture 18 - Application of FDM to Advection-Diffusion and Computer Implementation Aspects
- Lecture 19 - Computer Implementation of FDM for Steady State Heat Diffusion Problems - 1
- Lecture 20 - Computer Implementation of FDM for Steady State Heat Diffusion Problems - 2
- Lecture 21 - Computer Implementation of FDM for Steady State Heat Diffusion Problems - 3
- Lecture 22 - Solution of Discrete Algebraic Systems
- Lecture 23 - Direct and Basic Iterative Methods for Linear Systems
- Lecture 24 - Accelerated Iterative Methods for Linear Systems
- Lecture 25 - Two Level and Multi-Level Methods for First Order IVPs - 1
- Lecture 26 - Two Level and Multi-Level Methods for First Order IVPs - 2
- Lecture 27 - Application to Unsteady Transport Problems
- Lecture 28 - Introduction to Finite Volume Method
- Lecture 29 - Finite Volume Interpolation Schemes
- Lecture 30 - Application of FVM to Scalar Transport
- Lecture 31 - Introduction to Finite Element Method

[Lecture 32 - Finite Element Shape Functions and Numerical Integration - 1](#)

[Lecture 33 - Finite Element Shape Functions and Numerical Integration - 2](#)

[Lecture 34 - Application of FEM to Scalar Transport](#)

[Lecture 35 - Special Features of Navier-Stokes Equations](#)

[Lecture 36 - Time Integration Techniques for Navier-Stokes Equations](#)

[Lecture 37 - Implicit Pressure Correction Methods](#)

[Lecture 38 - SIMPLEC, SIMPLER and Fractional Step Methods](#)

[Lecture 39 - Turbulent Flows: Features and Simulation Strategies](#)

[Lecture 40 - Reynolds Averaging and RANS Simulation Models](#)

[Lecture 41 - RANS Turbulence Models and Large Eddy Simulation](#)

[Lecture 42 - Introduction to Grid Generation](#)

[Lecture 43 - Aspects of Practical CFD Analysis](#)

**NPTEL : Metal Casting (Mechanical Engineering)**

**Co-ordinators : Dr. D. B. Karunakar**

Lecture 1 - Introduction

Lecture 2 - Overview of different casting processes - 1

Lecture 3 - Overview of different casting processes - 2

Lecture 4 - Overview of different casting processes - 3

Lecture 5 - Terminology and Tools of Sand Moulding

Lecture 6 - Moulding Sands and Design - 1

Lecture 7 - Moulding Sands and Design - 2

Lecture 8 - Moulding Sands Properties

Lecture 9 - Moulding Sand Properties Testing

Lecture 10 - Cores and Core Sands

Lecture 11 - Patterns and Allowances

Lecture 12 - Steps Involved in Making a Sand Casting

Lecture 13 - Design of Riser System - 1

Lecture 14 - Design of Riser System - 2

Lecture 15 - Design of Riser System - 3

Lecture 16 - Design of Riser System - 4

Lecture 17 - Design of Riser System - 5

Lecture 18 - Design of Gating System - 1

Lecture 19 - Design of Gating System - 2

Lecture 20 - Sand Casting Defects - 1

Lecture 21 - Sand Casting Defects - 2

Lecture 22 - Melting Furnaces and Practice

Lecture 23 - Treatment of Molten Metal

Lecture 24 - Fluidity of Molten Metal

Lecture 25 - Solidification

Lecture 26 - Cast Irons and Steels

Lecture 27 - Aluminum and Magnesium Cast Alloys

Lecture 28 - Copper, Zinc and Titanium Cast Alloys

Lecture 29 - Die Casting Process - I

Lecture 30 - Die Casting Process - II

Lecture 31 - Investment Casting Process - I

[Lecture 32 - Investment Casting Process - II](#)

[Lecture 33 - Continuous Casting Process](#)

[Lecture 34 - Centrifugal Casting Process](#)

[Lecture 35 - Evaporative Pattern Casting and Plaster Moulding](#)

[Lecture 36 - Vacuum Sealed Moulding and Squeeze Casting](#)

[Lecture 37 - Shakeout, Fettling and Finishing](#)

[Lecture 38 - Inspection, Testing and Quality Control](#)

[Lecture 39 - Design Consideration and Economics](#)

[Lecture 40 - Environment, Health and Safety Aspects](#)

Lecture 1 - Engineering Materials and Processing Techniques: Introduction

Lecture 2 - Properties of Non-Metals

Lecture 3 - Glass Structure and Properties

Lecture 4 - Glass Processing - I

Lecture 5 - Glass Processing - II

Lecture 6 - Ceramics - I

Lecture 7 - Ceramics - II

Lecture 8 - Ceramic Powder Preparation

Lecture 9 - Ceramic Powder Preparation - I

Lecture 10 - Processing of Ceramic Parts - Pressing

Lecture 11 - Processing of Ceramic Parts - II

Lecture 12 - Ceramics: Secondary Processing

Lecture 13 - Thermoplastics and Thermosets

Lecture 14 - Processing of Plastics

Lecture 15 - Extrusion of Plastics

Lecture 16 - Transfer Molding and Compression Molding

Lecture 17 - Injection Molding

Lecture 18 - Thermoforming

Lecture 19 - Rotational Molding and Blow Molding

Lecture 20 - Composite Materials

Lecture 21 - Composite Materials: Classification and Applications

Lecture 22 - Processing of Polymer Matrix Composites

Lecture 23 - Hand Lay-up and Spray Lay-up

Lecture 24 - Pultrusion

Lecture 25 - Compression Molding

Lecture 26 - Filament Winding

Lecture 27 - Injection Molding-1

Lecture 28 - Pre-pregging and Sheet Molding Compounds

Lecture 29 - Resin Transfer Molding and Autoclave Molding

Lecture 30 - Ceramic Matrix Composites

Lecture 31 - Ceramic Matrix Composites: Fundamentals and Properties

[Lecture 32 - Powder Processing: Ceramic Matrix Composites](#)

[Lecture 33 - Chemical Vapour Infiltration](#)

[Lecture 34 - Ceramic Matrix Composites: Processing-1](#)

[Lecture 35 - Ceramic Matrix Composites: Post Processing](#)

[Lecture 36 - Drilling of Polymer Matrix Composites](#)

[Lecture 37 - Hole Making Techniques for Polymer Matrix Composites](#)

[Lecture 38 - Joining of Polymer Matrix Composites](#)

[Lecture 39 - Microwave Joining of Polymer Matrix Composites](#)

[Lecture 40 - Research Tools for Secondary Processing](#)

**NPTEL : Vibration control (Mechanical Engineering)**

**Co-ordinators : Dr. S. P. Harsha**

Lecture 1 - Basics of Vibrations for Simple Mechanical Systems

Lecture 2 - Introduction to Damping in Free and Force Vibrations

Lecture 3 - Free and Forced Vibrations of Two Degree of Systems

Lecture 4 - Multi Degree of Freedom Systems

Lecture 5 - Reduction at source - 1

Lecture 6 - Reduction at source - 2

Lecture 7 - Reduction at source - 3

Lecture 8 - Feedback Control System - 1

Lecture 9 - Shunt Damping

Lecture 10 - Vibration Isolation - 1

Lecture 11 - Vibration Isolation - 2

Lecture 12 - Vibration Isolation - 3

Lecture 13 - Source Classification

Lecture 14 - Self Excitation Vibration

Lecture 15 - Flow Induction Vibration

Lecture 16 - Field Balancing of Rigid / Flexible Rotors

Lecture 17 - Damping: Models and Measures - I

Lecture 18 - Damping: Models and Measures - II

Lecture 19 - Numerical Problems

Lecture 20 - Design Sensitivity - I

Lecture 21 - Design Specification

Lecture 22 - Design for Enhanced Material Damping

Lecture 23 - Basics of Passive Vibration Control

Lecture 24 - Design of Absorber

Lecture 25 - Shock Absorber

Lecture 26 - Isolators with Stiffness and Damping

Lecture 27 - Basics of Active Vibration Control

Lecture 28 - Piezoelectric Material - I

Lecture 29 - Piezoelectric Material - II: Applications

Lecture 30 - Piezoelectric Accelerometers

Lecture 31 - Electro-rheological (ER) Fluids

[Lecture 32 - Magneto-rheological \(MR\) Fluids](#)

[Lecture 33 - Magneto and Electrostrictive Materials](#)

[Lecture 34 - Shape Memory Alloy](#)

[Lecture 35 - Electro-Magnetics](#)

[Lecture 36 - Numerical Problems](#)

[Lecture 37 - Basics of Vibration Measurement System](#)

[Lecture 38 - Data Acquisition](#)

[Lecture 39 - Fourier Transformation](#)

[Lecture 40 - Filters](#)



- Lecture 1 - Introduction to Welding Engineering
- Lecture 2 - Classification of Welding Processes - I
- Lecture 3 - Classification of Welding Processes - II
- Lecture 4 - Sources of Heat and Protection of Weld pool
- Lecture 5 - Protection of Weld Pool
- Lecture 6 - Introduction
- Lecture 7 - Fundamentals of Arc Initiation
- Lecture 8 - Arc Maintenance & Arc Characteristics
- Lecture 9 - Arc Forces
- Lecture 10 - Arc Efficiency
- Lecture 11 - Melting Rate in Different Welding Processes
- Lecture 12 - Types of power sources and their characteristics - I
- Lecture 13 - Types of power sources and their characteristics - II
- Lecture 14 - SMAW - I
- Lecture 15 - SMAW - II
- Lecture 16 - GTAW - I
- Lecture 17 - GTAW - II
- Lecture 18 - PAW & SAW
- Lecture 19 - SAW
- Lecture 20 - GMAW
- Lecture 21 - Brazing, Soldering & Braze Welding
- Lecture 22 - Braze welding and Electroslag welding
- Lecture 23 - Weld Thermal Cycle
- Lecture 24 - Effect of WTC and Cooling rate in welding
- Lecture 25 - Cooling rate
- Lecture 26 - Peak temperature & Solidification rate
- Lecture 27 - Residual stress - I
- Lecture 28 - Residual stress - II
- Lecture 29 - Introduction
- Lecture 30 - Type of joints and welds
- Lecture 31 - Edge preparation

[Lecture 32 - Design for static and fatigue loading](#)

[Lecture 33 - Fatigue fracture of weld joints - I](#)

[Lecture 34 - Fatigue fracture of weld joints - II](#)

[Lecture 35 - Introduction-](#)

[Lecture 36 - DT & NDT](#)

[Lecture 37 - Understanding Weldability](#)

[Lecture 38 - Reactions in weldment](#)

[Lecture 39 - Weldability of Al alloys](#)

[Lecture 40 - Failure analysis and prevention](#)

Lecture 1 - Production Planning and Control

Lecture 2 - Product Design and Development

Lecture 3 - Statistical Process Control - Part I

Lecture 4 - Statistical Process Control - Part II

Lecture 5 - Statistical Process Control - Part III

Lecture 6 - Productivity

Lecture 7 - Factors Affecting the Productivity

Lecture 8 - Improving the Productivity Introduction to Work Study

Lecture 9 - Work Study Human Component and Method Study

Lecture 10 - Recording Techniques for Method Study - Part I

Lecture 11 - Recording Techniques for Method Study - Part II

Lecture 12 - Recording Techniques Critical Examination

Lecture 13 - Principles of Motion Economy

Lecture 14 - Work Measurement Time Study - Part I

Lecture 15 - Work Measurement Time Study - Part II

Lecture 16 - Performance Rating Allowances

Lecture 17 - Work Measurement: Work Sampling

Lecture 18 - PMT System Standard Data Method

Lecture 19 - Ergonomics

Lecture 20 - Metabolism and Organization at Work

Lecture 21 - Working Conditions Lights Vibrations

Lecture 22 - Materials Management - Part I

Lecture 23 - Materials Management - Part II

Lecture 24 - Materials Requirement Planning

Lecture 25 - Sales Forecasting - Part I

Lecture 26 - Sales Forecasting - Part II

Lecture 27 - Capacity Planning - Part I

Lecture 28 - Capacity Planning - Part II

Lecture 29 - Network Analysis - Part I

Lecture 30 - Network Analysis - Part II

Lecture 31 - Facility Design Part - Part I

[Lecture 32 - Facility Design Part - Part II](#)

[Lecture 33 - Facility Design Part - Part III](#)

[Lecture 34 - Facility Design Part - Part IV](#)

[Lecture 35 - Product Design Development](#)

[Lecture 36 - Materials Handling](#)

[Lecture 37 - Quality Concepts](#)

[Lecture 38 - Value Engineering](#)

[Lecture 39 - Reliability](#)

[Lecture 40 - Industrial Safety](#)

Lecture 1 - Powder Metallurgy - Part I

Lecture 2 - Powder Metallurgy - Part II

Lecture 3 - Powder Metallurgy - Part III

Lecture 4 - Metal Forming - Fundamentals

Lecture 5 - Forging

Lecture 6 - Swaging and Wire Drawing

Lecture 7 - Sheet Metal Operations - Part I

Lecture 8 - Sheet Metal Operations - Part II

Lecture 9 - Sheet Metal Operations - Part III

Lecture 10 - Sheet Metal Working - Presses

Lecture 11 - Sheet Metal Working - Equipment

Lecture 12 - High Energy Rate Forming Processes

Lecture 13 - Machining Fundamentals

Lecture 14 - Machining - Part I

Lecture 15 - Machining - Part II

Lecture 16 - Machining - Part III

Lecture 17 - Metal casting - Part I

Lecture 18 - Metal casting - Part II

Lecture 19 - Metal Casting - Part III

Lecture 20 - Metal Casting - Part IV

Lecture 21 - Metal Casting - Part V

Lecture 22 - Metal Casting - Part VI

Lecture 23 - Metal Casting - Part VII

Lecture 24 - Metal Casting - Part VIII

Lecture 25 - Metal Casting - Part IX

Lecture 26 - Metal Casting - Part X

Lecture 27 - Introduction

Lecture 28 - Welding Process Classification

Lecture 29 - Brazing Soldering Braze Welding

Lecture 30 - Arc Welding Power Source - Part I

Lecture 31 - Arc Welding Power Source - Part II

[Lecture 32 - Shielded Metal Arc Welding - Part I](#)

[Lecture 33 - Shielded Metal Arc Welding - Part II](#)

[Lecture 34 - Submerged Arc Welding](#)

[Lecture 35 - Gas Metal Arc Welding - Part I](#)

[Lecture 36 - Gas Metal Arc Welding - Part II](#)

[Lecture 37 - Tungsten Inert Gas Welding - Part I](#)

[Lecture 38 - Tungsten Inert Gas Welding - Part II](#)

[Lecture 39 - Resistance Welding Process](#)

[Lecture 40 - Reaction in Weld Region Welding Defects](#)

**NPTEL : Strength of Materials (Mechanical Engineering)**

**Co-ordinators : Dr. S.P. Harsha**

[Lecture 1 - Solid Mechanics](#)

[Lecture 2 - Strength of Materials](#)

[Lecture 3 - Strength of Materials](#)

[Lecture 4 - Solid Mechanics](#)

[Lecture 5 - Strength of Materials](#)

[Lecture 6 - Strength of Materials](#)

[Lecture 7 - Strength of Materials](#)

[Lecture 8 - Strength of Materials](#)

[Lecture 9 - Strength of Materials](#)

[Lecture 10 - Strength of Materials](#)

[Lecture 11 - Strength of Materials](#)

[Lecture 12 - Strength of Materials](#)

[Lecture 13 - Strength of Materials](#)

[Lecture 14 - Strength of Materials](#)

[Lecture 15 - Strength of Materials](#)

[Lecture 16 - Strength of Materials](#)

[Lecture 17 - Strength of Materials](#)

[Lecture 18 - Strength of Materials](#)

[Lecture 19 - Strength of Materials](#)

[Lecture 20 - Strength of Materials](#)

[Lecture 21 - Strength of Materials](#)

[Lecture 22 - Strength of Materials](#)

[Lecture 23 - Strength of Materials](#)

[Lecture 24 - Strength of Materials](#)

[Lecture 25 - Strength of Materials](#)

[Lecture 26 - Strength of Materials](#)

[Lecture 27 - Strength of Materials](#)

[Lecture 28 - Strength of Materials](#)

[Lecture 29 - Strength of Materials](#)

[Lecture 30 - Strength of Materials](#)

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[Lecture 35 - Strength of Materials](#)

[Lecture 36 - Strength of Materials](#)

[Lecture 37 - Strength of Materials](#)

[Lecture 38 - Strength of Materials](#)

[Lecture 39 - Strength of Materials](#)

[Lecture 40 - Strength of Materials](#)



Lecture 1 - Introduction

Lecture 2 - Flow Regimes

Lecture 3 - Homogeneous Model

Lecture 4 - Drift Flux Model

Lecture 5 - Separated Flow Model

Lecture 6 - Dispersed Flow

Lecture 7 - Slug Flow

Lecture 8 - Annular Flow

Lecture 9 - Droplet Annular and Stratified Flow

Lecture 10 - Measurement of Void Fraction

Lecture 11 - Signal Analysis

Lecture 12 - Two Fluid and Population Balance Model

Lecture 13 - Interface Tracking

Lecture 14 - Lattice Boltzmann Method

Lecture 15 - Smoothed Particle Hydrodynamics

Lecture 16 - Molecular Perspective of Two Phase Flow

Lecture 17 - Boiling Heat Transfer

Lecture 18 - Condensation

Lecture 19 - Solid-Liquid Flow

Lecture 20 - Gas-Solid Flow

Lecture 1 - Recapitulation of Thermodynamics

Lecture 2 - Introduction to Refrigeration

Lecture 3 - Air Refrigeration Cycle

Lecture 4 - Aircraft Refrigeration Cycles - 1

Lecture 5 - Aircraft Refrigeration Cycles - 2

Lecture 6 - Aircraft Refrigeration Cycles - 3

Lecture 7 - Vapour Compression Cycle - 1

Lecture 8 - Vapour Compression Cycle - 2

Lecture 9 - P-h Charts

Lecture 10 - Actual Vapour Compression Cycle - 1

Lecture 11 - Actual Vapour Compression Cycle - 2

Lecture 12 - Compound Compression with Intercooling - 1

Lecture 13 - Compound Compression with Intercooling - 2

Lecture 14 - Multiple Evaporator and Cascade System

Lecture 15 - Problem Solving - 1

Lecture 16 - Refrigerants - 1

Lecture 17 - Refrigerants - 2

Lecture 18 - Vpour Absorption Systems - 1

Lecture 19 - Vpour Absorption Systems - 2

Lecture 20 - Vpour Absorption Systems - 3

Lecture 21 - Introduction to Air-conditioning

Lecture 22 - Properties of Moist Air

Lecture 23 - Psychrometric Chart

Lecture 24 - Psychrometric Processes - 1

Lecture 25 - Psychrometric Processes - 2

Lecture 26 - Psychrometric Processes - 3

Lecture 27 - Infiltration

Lecture 28 - Design Conditions

Lecture 29 - Cooling Load - 1

Lecture 30 - Cooling Load - 2

Lecture 31 - Cooling Load - 3

[Lecture 32 - Air Distribution System - 1](#)

[Lecture 33 - Air Distribution System - 2](#)

[Lecture 34 - Problem Solving - 2](#)

[Lecture 35 - Air-Conditioning Systems](#)

[Lecture 36 - Human Physiology](#)

[Lecture 37 - Thermal Comfort](#)

[Lecture 38 - Indoor Environmental Health - 1](#)

[Lecture 39 - Indoor Environmental Health - 2](#)

[Lecture 40 - Problem Solving - 3](#)

- Lecture 1 - Introduction to Engineering Economy, Physical and Economic Environment, Phases in Engg. process
- Lecture 2 - Some economic concepts, Value and utility, Interest and Interest rate, Time value of money
- Lecture 3 - Interest formulas: Simple and compound interest, Cash flow diagrams
- Lecture 4 - Interest formulas for discrete compounding and discrete payments: Single payment (CAF and PWF)
- Lecture 5 - Interest formulas for discrete compounding and discrete payments: Equal payment series (CAF, CRF and PWF)
- Lecture 6 - Problem solving on discrete compounding, discrete payment
- Lecture 7 - Interest formulas for Uniform gradient series
- Lecture 8 - Interest formulas for geometric gradient series
- Lecture 9 - Compounding frequency of Interest: Nominal and Effective interest rates
- Lecture 10 - Problem solving on frequency compounding of interest and gradient series factors
- Lecture 11 - Economic equivalence: Meaning and principles of equivalence
- Lecture 12 - Equivalence calculations involving cash flows
- Lecture 13 - Methods of comparison of alternatives: Present worth, Annual equivalent, Future worth, Internal rate of return
- Lecture 14 - comparison of alternatives: Capitalized equivalent amount, Capital recovery with return
- Lecture 15 - Problem solving on equivalence and comparison of alternatives
- Lecture 16 - Replacement analysis: Reason, Concept of defender and challenger
- Lecture 17 - Proper treatment of sunk cost in replacement
- Lecture 18 - Replacement because of improved efficiency, inadequacy, demand etc.
- Lecture 19 - Problem solving on replacement analysis
- Lecture 20 - Economic life of the asset
- Lecture 21 - Depreciation: Definition, Reasons, Types of property, Value time function and book value
- Lecture 22 - Basic depreciation methods:S-L method, Declining balance method
- Lecture 23 - Depreciation: Declining balance switching to S-L, SOYD Method
- Lecture 24 - Modified accelerated cost recovery system (MACRS) method of depreciation, Depletion
- Lecture 25 - Depreciation: Units of production method, Depletion
- Lecture 26 - Problem solving based on Depreciation and Depletion
- Lecture 27 - Elements of cost: types of cost
- Lecture 28 - Breakeven analysis, Effect of fixed and variable cost on BEP.
- Lecture 29 - Economic order quantity
- Lecture 30 - Problem solving based on Breakeven analysis and EOQ
- Lecture 31 - Cost estimation: Methods of cost estimation, Adjustment of data, Learning

[Lecture 32 - cost estimating relationships](#)

[Lecture 33 - Introduction to decision under risk Criteria for decision under risk](#)

[Lecture 34 - Expected value decision making under risk](#)

[Lecture 35 - Expected variance decision making under risk](#)

[Lecture 36 - Problem solving based on decision under risk](#)

[Lecture 37 - Income taxes: Principles and calculation of effective income tax rates](#)

[Lecture 38 - Effect of method of depreciation on income taxes](#)

[Lecture 39 - After tax economic analysis](#)

[Lecture 40 - Problem solving based on Income tax analysis](#)

Lecture 1 - Introduction

Lecture 2 - Balance of Total Energy

Lecture 3 - Different Forms of Thermal Energy Equation

Lecture 4 - Thermal Boundary Layer

Lecture 5 - Forced Convection : Low Prandtl Number over a Flat Plate

Lecture 6 - Forced Convection : High Prandtl Number over a Flat Plate

Lecture 7 - Forced Convection over a Flat Plate : Uniform Heat Flux

Lecture 8 - Natural Convection : Uniform Wall Temperature

Lecture 9 - Natural Convection : Uniform Heat Flux

Lecture 10 - Tutorial : Convection over Flat Plate

Lecture 11 - Forced Convection in Ducts

Lecture 12 - Thermally Developed Slug Flow in a Duct

Lecture 13 - Thermally and Hydrodynamically Developed Flow : Uniform Heat Flux

Lecture 14 - Thermally and Hydrodynamically Developed Flow : Uniform Wall Temperature

Lecture 15 - Thermal Entrance Region : Uniform Wall Temperature

Lecture 16 - Thermal Entrance Region : Uniform Heat Flux

Lecture 17 - Rayleigh Benard Convection

Lecture 18 - Heat Transfer with Phase Change

Lecture 19 - Mass Transfer

Lecture 20 - Tutorial : Convection inside Duct and Mass Transfer

Lecture 1 - Lesson 1 - Introduction

Lecture 2 - Lesson 2 - Addition of two harmonic motions and beat phenomenon

Lecture 3 - Lesson 3 - Fourier series and harmonic analysis

Lecture 4 - Lesson 4 - Vibration analysis procedure

Lecture 5 - Lesson 5 - Numerical problems

Lecture 6 - Lesson 1 - Undamped free vibration

Lecture 7 - Lesson 2 - Energy method

Lecture 8 - Lesson 3 - Damped free vibration

Lecture 9 - Lesson 4 - Viscous damped systems and logarithmic decrement

Lecture 10 - Lesson 5 - Coulomb damping

Lecture 11 - Lesson 1 - Harmonic excitations

Lecture 12 - Lesson 2 - Magnification factor and frequency response curve

Lecture 13 - Lesson 3 - Rotating unbalance

Lecture 14 - Lesson 4 - Excitation of the support

Lecture 15 - Lesson 5 - Energy input and dissipation by viscous damping

Lecture 16 - Lesson 1 - Coulomb damping and equivalent viscous damping

Lecture 17 - Lesson 2 - Structural damping and equivalent viscous damping

Lecture 18 - Lesson 3 - Vibration isolation and force transmissibility

Lecture 19 - Lesson 4 - Motion transmissibility

Lecture 20 - Lesson 5 - Numerical problems

Lecture 21 - Lesson 1 - Transducers and vibration pickup

Lecture 22 - Lesson 2 - Vibrometer

Lecture 23 - Lesson 3 - Accelerometer

Lecture 24 - Lesson 4 - Velocity pickup or Velometer

Lecture 25 - Lesson 5 - Phase distortion and frequency measurement

Lecture 26 - Lesson 1 - Undamped free vibration

Lecture 27 - Lesson 2 - Principal modes of vibration

Lecture 28 - Lesson 3 - Combined rectilinear and angular modes

Lecture 29 - Lesson 4 - Damped free vibration

Lecture 30 - Lesson 5 - Undamped forced vibration with harmonic excitation

Lecture 31 - Lesson 1 - Undamped dynamic vibration absorber

[Lecture 32 - Lesson 2 - Tuned absorber](#)

[Lecture 33 - Lesson 3 - Numerical problems](#)

[Lecture 34 - Lesson 4 - Damped dynamic vibration absorber](#)

[Lecture 35 - Lesson 5 - Optimally tuned vibration absorber](#)

[Lecture 36 - Lesson 1 - Undamped free vibration](#)

[Lecture 37 - Lesson 2 - Eigen values and eigen vectors](#)

[Lecture 38 - Lesson 3 - Flexibility influence coefficients](#)

[Lecture 39 - Lesson 4 - Stiffness influence coefficients](#)

[Lecture 40 - Lesson 5 - Static and dynamic coupling](#)



- Lecture 1 - Introduction: Manufacturing and Joining
- Lecture 2 - Fundamental mechanisms of Joining
- Lecture 3 - Classification of Joining Processes
- Lecture 4 - Heat Generation in Welding
- Lecture 5 - Protection of Weld Metal
- Lecture 6 - Principle of Fusion Welding Processes: Gas Welding
- Lecture 7 - Fundamentals of Welding
- Lecture 8 - Physics of Welding Arc
- Lecture 9 - Shielded Metal Arc Welding
- Lecture 10 - Gas Tungsten Arc Welding
- Lecture 11 - Newer variants of Gas tungsten arc welding
- Lecture 12 - Gas metal arc welding
- Lecture 13 - Submerged arc welding
- Lecture 14 - Electro-slag and Electro-gas welding
- Lecture 15 - Laser beam welding
- Lecture 16 - Brazing
- Lecture 17 - Soldering and braze welding
- Lecture 18 - Fundamentals of resistance welding
- Lecture 19 - Resistance welding processes: spot and seam welding
- Lecture 20 - Flash butt welding
- Lecture 21 - Adhesive joining
- Lecture 22 - Weld bonding
- Lecture 23 - Solid state joining technologies: Fundamentals
- Lecture 24 - Ultrasonic welding
- Lecture 25 - Diffusion welding
- Lecture 26 - Explosive welding
- Lecture 27 - Magnetic pulse welding
- Lecture 28 - Weld thermal cycle
- Lecture 29 - Heat affected zone and weld thermal cycle - I
- Lecture 30 - Heat affected zone and weld thermal cycle - II
- Lecture 31 - Solidification of weld metal

- Lecture 32 - Metallurgical transformations in weld and heat affected zone of steels
- Lecture 33 - Residual Stresses in Weld Joints
- Lecture 34 - Solidification cracking and their control
- Lecture 35 - Cracking of Welded Joints II - Cold Cracks
- Lecture 36 - Understanding Weldability Introduction - I
- Lecture 37 - Understanding Weldability Introduction - II
- Lecture 38 - Metal Properties and Weldability - I
- Lecture 39 - Metal Properties and Weldability - II
- Lecture 40 - Weldability of Work Hardenable Metals
- Lecture 41 - Weldability of Work Hardenable and Precipitation Strengthened Metals
- Lecture 42 - Weldability of Precipitation Strengthened Metals
- Lecture 43 - Weldability of Metals Strengthened by Grain Refinement and Transformation Hardening
- Lecture 44 - Weldability of Transformation Hardening Metals
- Lecture 45 - Weldability of Metals - Combination of Strengthening Mechanisms
- Lecture 46 - Weldability Consideration
- Lecture 47 - Weldability of Carbon and Alloy Steel - I
- Lecture 48 - Weldability of Carbon and Alloy Steel - II
- Lecture 49 - Weldability of Carbon and Alloy Steel - III
- Lecture 50 - Weldability of Low Carbon Steel and Mild Steel
- Lecture 51 - Weldability of Medium Carbon Steel and High Carbon Steel
- Lecture 52 - Weldability of High Strength Low Alloy Steels
- Lecture 53 - Weldability of HTLA Steel - I
- Lecture 54 - Weldability of HTLA Steel - II
- Lecture 55 - Weldability of Cr-Mo Steel - I
- Lecture 56 - Weldability of Cr-Mo Steel - II
- Lecture 57 - Weldability of Pre-coated Steel - I
- Lecture 58 - Weldability of Pre-coated Steel - II
- Lecture 59 - Weldability of Stainless Steel - I
- Lecture 60 - Weldability of Stainless Steel - II

- Lecture 1 - Introduction to Modelling
- Lecture 2 - Examples of models
- Lecture 3 - Modeling of Dynamic Systems
- Lecture 4 - Introduction to Simulation
- Lecture 5 - MATLAB as a Simulation tool
- Lecture 6 - Bond graphs modelling
- Lecture 7 - Bond graph model and causality
- Lecture 8 - Generation of System Equations
- Lecture 9 - Methods of Drawing bond graph models - Mechanical Systems
- Lecture 10 - Methods of Drawing bond graph models - Electrical Systems
- Lecture 11 - Basic System Models - Mechanical Systems
- Lecture 12 - Basic System Models - Electrical Systems
- Lecture 13 - Basic System Models - Hydraulic Systems
- Lecture 14 - Basic System Models - Pneumatic Systems
- Lecture 15 - Basic System Models - Thermal Systems
- Lecture 16 - System Models : Linearity and Non Linearity in Systems
- Lecture 17 - System Model of Combined Rotary and Translatory Systems
- Lecture 18 - System Model of Electro Mechanical Systems
- Lecture 19 - System Model of Hydro Mechanical Systems
- Lecture 20 - System Models of Robots
- Lecture 21 - Dynamic response of the 1st order system
- Lecture 22 - Dynamic response of 2nd order system
- Lecture 23 - Performance measures for 2nd order system
- Lecture 24 - System Transfer functions
- Lecture 25 - Transfer Function of 1st and 2nd Order System
- Lecture 26 - Block Diagram Algebra
- Lecture 27 - Signal Flow Graphs
- Lecture 28 - State Variable Formulation
- Lecture 29 - Frequency Response
- Lecture 30 - Bode Plot
- Lecture 31 - Simulation using SIMULINK

[Lecture 32 - Simulation of simple and compound pendulums](#)

[Lecture 33 - Simulation of planar mechanisms](#)

[Lecture 34 - Simulation of wheeled mobile robots](#)

[Lecture 35 - Validation and Verification of Simulation Models](#)

[Lecture 36 - Parameter estimation methods](#)

[Lecture 37 - Parameter estimation examples](#)

[Lecture 38 - System identifications](#)

[Lecture 39 - Introduction to Optimization](#)

[Lecture 40 - Optimization with modeling of engineering problems](#)

Lecture 1 - Introduction to Casting Technology

Lecture 2 - Mechanism of solidification

Lecture 3 - Solidification of Pure Metals and Alloys

Lecture 4 - Freeze Wave Mechanism and Solidification Time

Lecture 5 - Problem Solving on Solidification

Lecture 6 - Technology of pattern making

Lecture 7 - Allowances in pattern making

Lecture 8 - Moulding sands and its ingredients

Lecture 9 - Testing of molding sands

Lecture 10 - Sand preparation for casting

Lecture 11 - Technology of mould making

Lecture 12 - Technology of core making

Lecture 13 - Special sand moulding process

Lecture 14 - Organic binders

Lecture 15 - Special moulding process

Lecture 16 - Introduction of gating design

Lecture 17 - Types of gate

Lecture 18 - Pouring time calculation

Lecture 19 - Aspiration effects in gating system

Lecture 20 - Problem solving on gating design

Lecture 21 - Solidification analysis

Lecture 22 - Riser methods

Lecture 23 - Shape factor

Lecture 24 - Feeding and Chills effect

Lecture 25 - Problem related to riser design

Lecture 26 - Special casting process - 1

Lecture 27 - Special casting process - 2

Lecture 28 - Special casting process - 3

Lecture 29 - Technology of melting

Lecture 30 - Melting practices

Lecture 31 - Melting and Casting of cast metal

[Lecture 32 - Melting practice for gray iron](#)

[Lecture 33 - Melting practice for Malleable iron and S.G iron](#)

[Lecture 34 - Casting of steel and alloy steel](#)

[Lecture 35 - Casting practices for non-ferrous metals and alloys](#)

[Lecture 36 - Fettling of castings](#)

[Lecture 37 - Heat treatment of castings](#)

[Lecture 38 - Heat treatment practices for cast iron and non-ferrous metals and alloys](#)

[Lecture 39 - Casting defects](#)

[Lecture 40 - Diagnostics of casting defects](#)

Lecture 1 - Review of Thermodynamics

Lecture 2 - Rankine Cycle

Lecture 3 - Performance of Rankine Cycle

Lecture 4 - Binary vapour cycle and co-generation

Lecture 5 - Problem Solving (Rankine Cycle)

Lecture 6 - Steam Generators

Lecture 7 - Fire Tube Boilers

Lecture 8 - Water Tube Boilers

Lecture 9 - Boiler Mountings and Accessories

Lecture 10 - High Pressure Boilers (Part-1)

Lecture 11 - High Pressure Boilers (Part-2)

Lecture 12 - Draught

Lecture 13 - Performance of Boiler

Lecture 14 - Combustion of Fuel

Lecture 15 - Combustion of Fuel (Problem Solving)

Lecture 16 - Boiler Trial

Lecture 17 - Nozzles and Diffusers - Momentum and Continuity Equations

Lecture 18 - Nozzles and Diffusers - Efficiency and Critical Pressure

Lecture 19 - Nozzles and Diffusers - General Relationships and Supersaturated Flow

Lecture 20 - Problem Solving (Nozzles and diffusers)

Lecture 21 - Steam Turbine

Lecture 22 - Compounding of Steam Turbine

Lecture 23 - Impulse Steam Turbine

Lecture 24 - Impulse Steam Turbine Performance

Lecture 25 - Problem solving (Impulse Steam Turbine)

Lecture 26 - Impulse Reaction Steam Turbine

Lecture 27 - Impulse Reaction Steam Turbine Performance

Lecture 28 - Energy Losses in Steam Turbine

Lecture 29 - Condensers

Lecture 30 - Problem Solving (Steam Turbine)

Lecture 31 - Gas turbine cycle

[Lecture 32 - Gas Turbine cycle Performance Evaluations](#)

[Lecture 33 - Gas Turbine cycle - Modifications](#)

[Lecture 34 - Problem Solving \(Gas Turbine Cycle\)](#)

[Lecture 35 - Centrifugal Compressors](#)

[Lecture 36 - Centrifugal Compressors Characteristics](#)

[Lecture 37 - Axial Flow Compressor](#)

[Lecture 38 - Axial Flow Compressor Characteristics](#)

[Lecture 39 - Jet Propulsion](#)

[Lecture 40 - Problem Solving](#)



Lecture 1 - Introduction to product design and development

Lecture 2 - Product life-cycle

Lecture 3 - Product policy of an organization and selection of profitable products

Lecture 4 - Product design

Lecture 5 - Product design steps and product analysis

Lecture 6 - Value engineering concepts

Lecture 7 - Problem Identification and VEJP

Lecture 8 - Function analysis

Lecture 9 - Functional analysis system technique

Lecture 10 - Case study on value engineering

Lecture 11 - Quality function deployment

Lecture 12 - Computer aided design

Lecture 13 - Robust design

Lecture 14 - Design for X

Lecture 15 - Ergonomics in product design

Lecture 16 - DFMA guidelines

Lecture 17 - Product design for manual assembly

Lecture 18 - Design guidelines for different processes

Lecture 19 - Rapid prototyping: concept, advantages

Lecture 20 - Rapid prototyping processes

- Lecture 1 - Understanding Manufacturing
- Lecture 2 - Fundamental Approaches of Manufacturing
- Lecture 3 - Manufacturing Process Specific Advantages and Limitations
- Lecture 4 - Material and Manufacturing Processes
- Lecture 5 - Classification of Manufacturing Processes
- Lecture 6 - Selection of Manufacturing Processes
- Lecture 7 - Applications of Manufacturing Processes
- Lecture 8 - Effect of Manufacturing Processes on Mechanical Properties
- Lecture 9 - Break Even Analysis in Manufacturing Processes
- Lecture 10 - Casting: Introduction and Suitability
- Lecture 11 - Steps of Casting Processes
- Lecture 12 - Casting: Terminology
- Lecture 13 - The Pattern Allowances - I
- Lecture 14 - The Pattern Allowances - II
- Lecture 15 - Casting: Sand Moulding - I
- Lecture 16 - Sand Moulding - II
- Lecture 17 - Casting: Core and Core Prints
- Lecture 18 - Casting: Gating System
- Lecture 19 - Casting: Yield and Riser Design
- Lecture 20 - Casting: Riser Design
- Lecture 21 - Casting: Cleaning of Castings
- Lecture 22 - Casting: Casting Defects and their Preventions
- Lecture 23 - Casting: Shell Mould Casting
- Lecture 24 - Casting: Investment and Permanent Mould Casting
- Lecture 25 - Metal Working Processes: Hot and Cold Working
- Lecture 26 - Metal Working Processes: Rolling
- Lecture 27 - Metal Working Processes: Forging
- Lecture 28 - Metal Working Processes: Extrusion
- Lecture 29 - Metal Working Processes: Wire Drawing
- Lecture 30 - Metal Working Processes: Press
- Lecture 31 - Sheet Metal Operations: Shearing

- Lecture 32 - Metal Working Processes: Sheet Metal Operations - II
- Lecture 33 - Metal Working Processes: Sheet Metal Operations - III
- Lecture 34 - Metal Working Processes: Dies and Die sets
- Lecture 35 - Material Removal Processes: Machining
- Lecture 36 - Material Removal Processes: Mechanism of Metal Cutting
- Lecture 37 - Material Removal Processes: Chip Formation
- Lecture 38 - Material Removal Processes: Types of Chips and Power Consumption
- Lecture 39 - Material Removal Processes: Heat Generation
- Lecture 40 - Material Removal Processes: Tool Failure and Tool Life
- Lecture 41 - Material Removal Processes: Tool materials
- Lecture 42 - Material removal processes: Cutting fluids
- Lecture 43 - Material removal processes: Grinding - I
- Lecture 44 - Material removal Processes: Grinding - II
- Lecture 45 - Material removal Processes: Grinding - III
- Lecture 46 - Material removal processes: Grinding operations
- Lecture 47 - Joining of metals: Fundamentals - I
- Lecture 48 - Joining of metals: Fundamentals - II
- Lecture 49 - Joining of metals: Welding processes - I
- Lecture 50 - Brazing, soldering and weldability
- Lecture 51 - Weldability and welding defects
- Lecture 52 - Heat treatment: Fundamentals - I
- Lecture 53 - Heat treatment: Fundamentals - II
- Lecture 54 - Heat treatment: Fundamentals - III
- Lecture 55 - Heat treatment: Normalizing and hardening
- Lecture 56 - Heat treatment: Tempering
- Lecture 57 - Improving surface properties: Introduction
- Lecture 58 - Improving surface properties: Surface modification processes I
- Lecture 59 - Improving surface properties: Changing chemical composition
- Lecture 60 - Improving surface properties: Coating

Lecture 1 - Introduction to Simulation

Lecture 2 - Concept of System, Model and Simulation

Lecture 3 - Time advance mechanism, Components of a simulation model

Lecture 4 - Program organization and logic, Steps in a simulation study

Lecture 5 - Simulation examples

Lecture 6 - Statistical Models in Simulation

Lecture 7 - Input probability distribution functions for discrete systems

Lecture 8 - Continuous distribution functions

Lecture 9 - Continuous distribution functions and empirical distribution functions

Lecture 10 - Problem solving on statistical models in simulation

Lecture 11 - Characteristics of a queueing system

Lecture 12 - Performance measures of queueing system

Lecture 13 - Analysis of a single server queueing system

Lecture 14 - Simulation of a single server queueing system

Lecture 15 - Computer representation of simulation of single server queuing system

Lecture 16 - Generation of Random Numbers

Lecture 17 - Issues and Challenges in Congruential Generators

Lecture 18 - Testing of random numbers

Lecture 19 - Generation of Random Variates

Lecture 20 - Problem Solving on Random Number and Random Variate Generation

Lecture 21 - Input modeling: Identifying distributions with data

Lecture 22 - Input modeling: Estimation of parameters

Lecture 23 - Input modeling: Goodness-of-fit tests and assessing sample dependence

Lecture 24 - Input modeling: Multivariate input models

Lecture 25 - Problem Solving on input modeling

Lecture 26 - Output analysis of a single system: Introduction

Lecture 27 - Obtaining a specified precision

Lecture 28 - Comparison of alternative system configurations

Lecture 29 - Confidence Intervals for comparing more than two systems

Lecture 30 - Problem Solving on output analysis of single and alternative systems

Lecture 31 - Introduction to simulation of manufacturing and material handling system

[Lecture 32 - Issues in material handling system](#)

[Lecture 33 - Modeling of system randomness: Machine downtime](#)

[Lecture 34 - Verification of simulation models](#)

[Lecture 35 - Model validity and credibility](#)

[Lecture 36 - Problem solving and case studies on simulation of manufacturing system](#)

[Lecture 37 - Introduction to Monte Carlo Simulation](#)

[Lecture 38 - Inventory Control Simulation using Monte Carlo Technique](#)

[Lecture 39 - In this lecture, Monte Carlo technique was used to solve inventory system problems](#)

[Lecture 40 - Problem solving on Monte Carlo Simulation](#)

Lecture 1 - Introduction to course

Lecture 2 - Engineering materials and processing techniques

Lecture 3 - Thermoplastics and thermosets

Lecture 4 - Processing of polymers

Lecture 5 - Thermoforming processes

Lecture 6 - Extrusion - I

Lecture 7 - Extrusion - II

Lecture 8 - Compression molding

Lecture 9 - Injection molding - I

Lecture 10 - injection molding - II

Lecture 11 - Transfer molding

Lecture 12 - Rotational molding

Lecture 13 - Blow molding

Lecture 14 - Composite materials: Basic concepts

Lecture 15 - Classification of composite materials

Lecture 16 - Processing of polymer composites

Lecture 17 - Hand lay-up

Lecture 18 - Spray lay-up

Lecture 19 - Compression molding

Lecture 20 - Injection molding

Lecture 21 - Reaction injection molding

Lecture 22 - Autoclave molding

Lecture 23 - Resin transfer molding

Lecture 24 - Filament winding

Lecture 25 - Pultrusion process

Lecture 26 - Sheet molding

Lecture 27 - Pre-pregging and challenges in primary processing of composites

Lecture 28 - Secondary processing of polymer composites

Lecture 29 - Joining of polymer composites

Lecture 30 - Adhesive joining

Lecture 31 - Mechanical joining

[Lecture 32 - Microwave joining](#)

[Lecture 33 - Induction and resistance welding](#)

[Lecture 34 - Drilling of polymer matrix composites - I](#)

[Lecture 35 - Drilling of polymer matrix composites - II](#)

[Lecture 36 - Methods to prevent drilling induced damage](#)

[Lecture 37 - Non-conventional drilling](#)

[Lecture 38 - Process simulation of secondary processing](#)

[Lecture 39 - Intelligent drilling of polymer matrix composites](#)

[Lecture 40 - Web based tools for polymer matrix composites](#)

Lecture 1 - Operations Management: Basics

Lecture 2 - Operations Management: Objectives

Lecture 3 - Operations Management: Functions and Scope

Lecture 4 - Types of Production Systems

Lecture 5 - Operations Strategy

Lecture 6 - Product Life-Cycle

Lecture 7 - Value Engineering Concepts

Lecture 8 - Design for X (DFX)

Lecture 9 - Ergonomics in Product Design

Lecture 10 - Rapid Prototyping: Concept, Advantages

Lecture 11 - Sales Forecasting

Lecture 12 - Forecasting System

Lecture 13 - Qualitative Methods of Forecasting

Lecture 14 - Quantitative Methods - I

Lecture 15 - Quantitative Methods - II

Lecture 16 - Facility Planning

Lecture 17 - Factors Affecting Plant Location

Lecture 18 - Plant Location: Case Study on Uttarakhand

Lecture 19 - Location Evaluation Methods - I

Lecture 20 - Location Evaluation Methods - II

Lecture 21 - Facility Layout and Planning - I

Lecture 22 - Facility Layout and Planning - II

Lecture 23 - Factors Influencing Plant Layout

Lecture 24 - Material Flow Patterns

Lecture 25 - Tools and Techniques used For Plant Layout Planning

Lecture 26 - Production Planning and Control

Lecture 27 - Process Planning

Lecture 28 - Aggregate Production Planning

Lecture 29 - Capacity Planning: Introduction

Lecture 30 - Capacity Planning: Examples

Lecture 31 - Project Scheduling



[Lecture 32 - Network Diagrams](#)

[Lecture 33 - Critical Path Method](#)

[Lecture 34 - Critical Path Method: Problems - I](#)

[Lecture 35 - Critical Path Method: Problems - II](#)

[Lecture 36 - Program Evaluation and Review Technique \(PERT\)](#)

[Lecture 37 - PERT Problems - I](#)

[Lecture 38 - PERT Problems - II](#)

[Lecture 39 - Time Cost Trade Off \(Crashing\)](#)

[Lecture 40 - Project Network: Crashing Problems](#)

[Lecture 41 - Production Control](#)

[Lecture 42 - Sequencing](#)

[Lecture 43 - Sequencing Problems - I](#)

[Lecture 44 - Sequencing Problems - II](#)

[Lecture 45 - Master Production Scheduling \(MPS\)](#)

[Lecture 46 - Concept of Quality](#)

[Lecture 47 - Total Quality Management \(TQM\)](#)

[Lecture 48 - Total Productive Maintenance](#)

[Lecture 49 - Statistical Quality Control \(SQC\)](#)

[Lecture 50 - Six Sigma](#)

[Lecture 51 - Materials Management](#)

[Lecture 52 - Inventory Control](#)

[Lecture 53 - Economic Order Quantity \(EOQ\) Models](#)

[Lecture 54 - Economic Order Quantity \(EOQ\): Problems](#)

[Lecture 55 - Production Quantity Model](#)

[Lecture 56 - Just In time \(JIT\)](#)

[Lecture 57 - Kanban System](#)

[Lecture 58 - Materials Requirement Planning \(MRP\) - I](#)

[Lecture 59 - Materials Requirement Planning \(MRP\) - II](#)

[Lecture 60 - Enterprise Resource Planning \(ERP\)](#)

- Lecture 1 - Introduction to Theory and Practics of Casting
- Lecture 2 - Theory of Solidification: Cooling curves
- Lecture 3 - Solidification of pure metals and alloys
- Lecture 4 - Factors affecting solidification process
- Lecture 5 - Fluidity of liquid metals
- Lecture 6 - Technology of patternmaking: Pattern materials
- Lecture 7 - Patternmaking: Types of pattern and allowances
- Lecture 8 - Molding sand ingredients and sand testing methods
- Lecture 9 - Sand molding methods
- Lecture 10 - Coremaking: Properties and types of cores
- Lecture 11 - Gating system design: Types of gates
- Lecture 12 - Gating system design: Pouring time calculation
- Lecture 13 - Introduction to riser design
- Lecture 14 - Riser design methods
- Lecture 15 - Problem solving on gating design and riser design methods
- Lecture 16 - Theory of melting: Types of furnaces
- Lecture 17 - Melting and production of Iron castings
- Lecture 18 - Production of steel and non-ferrous castings
- Lecture 19 - Casting design considerations
- Lecture 20 - Casting defects: Types, causes and remedies
- Lecture 21 - Concept of stress and strain, Elastic and plastic behavior
- Lecture 22 - State of stress in two and three dimensions, Mohr's circle
- Lecture 23 - Description of strain at a point
- Lecture 24 - Mean and deviator stresses, Elastic stress strain relationships
- Lecture 25 - Theory of plasticity: True stress and true strain, Flow curve
- Lecture 26 - Yield criteria for ductile materials
- Lecture 27 - Flow rules, Plastic stress strain relationships
- Lecture 28 - Classification of metal working processes
- Lecture 29 - Mechanics of metal working
- Lecture 30 - Temperature in metalworking: Hot and cold working
- Lecture 31 - Rolling process: Classification, Hot and cold rolling

Lecture 32 - Analysis of rolling operation: Forces and geometrical relationships

Lecture 33 - Introduction to forging Process: Classification and equipments

Lecture 34 - Analysis of forging process

Lecture 35 - Problem solving on rolling and forging processes

Lecture 36 - Extrusion process: Classification and analysis

Lecture 37 - Drawing of rods, tubes and wires

Lecture 38 - Analysis of drawing operation

Lecture 39 - Sheet metal operations

Lecture 40 - Metal Forming Defects

Lecture 41 - Classification of joining processes

Lecture 42 - Heat flow in welding

Lecture 43 - Metallurgy of fusion welds

Lecture 44 - Heat affected zone in welding

Lecture 45 - Heat treatment processes in welding

Lecture 46 - Principle of shield arc welding processes

Lecture 47 - Principle of gas shield arc welding processes

Lecture 48 - Principle of Resistance welding

Lecture 49 - Principle of Solid State Welding Processes

Lecture 50 - Brazing, soldering and adhesive bonding

Lecture 51 - Residual stresses in welding

Lecture 52 - Methods of controlling residual stresses in welding

Lecture 53 - Welding Distortion

Lecture 54 - Control of welding distortion

Lecture 55 - Preheat and postweld heat treatment of weldments

Lecture 56 - Weldability of metals

Lecture 57 - Weldability of steels

Lecture 58 - Weldability of cast iron

Lecture 59 - Weldability of non-ferrous materials

Lecture 60 - Welding defects

Lecture 1 - Definition and Types

Lecture 2 - Performance Specifications

Lecture 3 - Design Process

Lecture 4 - Block Diagrams

Lecture 5 - Laplace Transform and Transfer Function

Lecture 6 - Translational Mechanical System

Lecture 7 - Rotational Mechanical System

Lecture 8 - Electrical System

Lecture 9 - Linearization of Nonlinear Systems

Lecture 10 - Numerical Problems

Lecture 11 - Poles and Zeros

Lecture 12 - First Order System

Lecture 13 - Second Order System

Lecture 14 - Underdamped Second Order System - I

Lecture 15 - Underdamped Second Order System - II

Lecture 16 - Definition of Stability

Lecture 17 - Routh-Hurwitz Criterion

Lecture 18 - Routh-Hurwitz Criterion- Special Cases

Lecture 19 - Steady State Errors

Lecture 20 - Static Error Constants

Lecture 21 - Define Root Locus

Lecture 22 - Sketching of Root Locus - I

Lecture 23 - Sketching of Root Locus - II

Lecture 24 - Sketching of Root Locus - III

Lecture 25 - Numerical Examples and Second Order Approximation

Lecture 26 - PI Controller Design

Lecture 27 - PD Controller Design

Lecture 28 - PID Controller Design

Lecture 29 - Lag Compensation

Lecture 30 - Lead and Lag-Lead Compensation

Lecture 31 - State Space Representation

[Lecture 32 - Converting a Transfer Function to State Space](#)

[Lecture 33 - Converting From State Space to Transfer Function](#)

[Lecture 34 - Controller Design](#)

[Lecture 35 - Controller Design and Controllability](#)

[Lecture 36 - Transfer Function, Poles, Zeros, Response](#)

[Lecture 37 - Steady State Error, Root Locus](#)

[Lecture 38 - Design Via Root Locus, Compensation - I](#)

[Lecture 39 - Design Via Root Locus, Compensation - II](#)

[Lecture 40 - State Space Method](#)

- Lecture 1 - Introduction - Need and scope of failure analysis and prevention
- Lecture 2 - Introduction - Engineering disasters and understanding failures
- Lecture 3 - Fundamental sources of failures - Deficient design - I
- Lecture 4 - Fundamental sources of failures - Deficient design - II
- Lecture 5 - Fundamental sources of failures - Deficient design - III and upgrading of a part
- Lecture 6 - Fundamental sources of failures - Imperfections in base metals
- Lecture 7 - Fundamental sources of failures - Improper Manufacturing - I
- Lecture 8 - Fundamental sources of failures - Improper Manufacturing - II
- Lecture 9 - Fundamental sources of failures - Improper Manufacturing - III
- Lecture 10 - Fundamental sources of failures - Improper Manufacturing - IV and improper service conditions
- Lecture 11 - Fundamental sources of failures - Poor assembly, service and maintenance
- Lecture 12 - Industrial engineering tool for failure analysis - Pareto diagram
- Lecture 13 - Industrial engineering tool for failure analysis - Fishbone diagram and FMEA
- Lecture 14 - Industrial engineering tool for failure analysis - FMEA
- Lecture 15 - Industrial engineering tool for failure analysis - Fault tree analysis
- Lecture 16 - Industrial engineering tool for failure analysis - Reliability - I
- Lecture 17 - Industrial engineering tool for failure analysis - Reliability - II
- Lecture 18 - General procedure of failure analysis - Steps
- Lecture 19 - General procedure of failure analysis - Background information collection
- Lecture 20 - General procedure of failure analysis - Preliminary examination
- Lecture 21 - General procedure of failure analysis - NDT for failure analysis
- Lecture 22 - General procedure of failure analysis - Destructive testing
- Lecture 23 - General procedure of failure analysis - DT, selection, preservation, cleaning and sectioning of samples
- Lecture 24 - General procedure of failure analysis - Macroscopy of fracture surfaces - I
- Lecture 25 - General procedure of failure analysis - Macroscopy of fracture surfaces - II
- Lecture 26 - General procedure of failure analysis - Macroscopy of fracture surfaces - III
- Lecture 27 - General procedure of failure analysis - Macroscopy of fracture surfaces - IV
- Lecture 28 - General procedure of failure analysis - Microscopy of fracture surfaces
- Lecture 29 - General procedure of failure analysis - Metallography of failed components
- Lecture 30 - General procedure of failure analysis - Determination of type of fracture - I
- Lecture 31 - General procedure of failure analysis - Determination of type of fracture - II

[Lecture 32 - General procedure of failure analysis - Determination of type of fracture - III and chemical analysis](#)

[Lecture 33 - General procedure of failure analysis - Application of fracture mechanics - I](#)

[Lecture 34 - General procedure of failure analysis - Application of fracture mechanics - II](#)

[Lecture 35 - General procedure of failure analysis - Simulated test service conditions and analysis of evidences](#)

[Lecture 36 - General procedure of failure analysis - Question for analysis](#)

[Lecture 37 - General procedure of failure analysis - Reporting failure analysis and failure analysis of welded joint](#)

[Lecture 38 - General procedure of failure analysis - Failure analysis of weld joint](#)

[Lecture 39 - General procedure of failure analysis - Examples of failure analysis](#)

[Lecture 40 - General procedure of failure analysis - Embrittlement of steels](#)

Lecture 1 - Basic concepts of measurement

Lecture 2 - Functional elements of instruments

Lecture 3 - Classification of measuring instruments

Lecture 4 - Methods of correction for interfering and modifying inputs

Lecture 5 - Static characteristics of measuring instruments - 1

Lecture 6 - Static characteristics of measuring instruments - 2

Lecture 7 - Loading effect and Impedance matching

Lecture 8 - Statistical analysis

Lecture 9 - Chi-square test

Lecture 10 - Least square method

Lecture 11 - Uncertainty analysis

Lecture 12 - Problem solving - 1

Lecture 13 - Generalized model of a measuring system

Lecture 14 - Zero and first order system

Lecture 15 - First order system - step response

Lecture 16 - First order system - ramp response

Lecture 17 - First order system - impulse response

Lecture 18 - First order system - frequency response

Lecture 19 - Second order system - step response - 1

Lecture 20 - Second order system - step response - 2

Lecture 21 - Second order system - ramp response

Lecture 22 - Second order system - impulse and frequency response

Lecture 23 - Higher order systems

Lecture 24 - Compensation

Lecture 25 - Transducers - 1

Lecture 26 - Transducers - 2

Lecture 27 - Flow measurement - 1

Lecture 28 - Flow measurement - 2

Lecture 29 - Temperature measurement - 1

Lecture 30 - Temperature measurement - 2

Lecture 31 - Strain gauges



[Lecture 32 - Piezoelectric transducers](#)

[Lecture 33 - Pressure measurement](#)

[Lecture 34 - Force and torque measurement](#)

[Lecture 35 - Displacement and acceleration measurement](#)

[Lecture 36 - Sound measurement](#)

[Lecture 37 - Thermophysical properties measurement](#)

[Lecture 38 - Flow visualization](#)

[Lecture 39 - Air pollution sampling and measurement](#)

[Lecture 40 - Problem solving - 2](#)

- Lecture 1 - Introduction and need of surface engineering
- Lecture 2 - Surface/sub-surface regions and properties of importance for surface engineering
- Lecture 3 - Surface properties and their modification
- Lecture 4 - Classification of surface modification techniques - I
- Lecture 5 - Classification of surface modification techniques - II
- Lecture 6 - Comparison of surface modification techniques and scope of surface engineering
- Lecture 7 - Scope of surface engineering - I
- Lecture 8 - Surface properties for wear and friction resistance - I
- Lecture 9 - Surface properties for wear and friction resistance - II
- Lecture 10 - Surface properties for wear and friction resistance - III
- Lecture 11 - Issues and application of surface modification
- Lecture 12 - Surface damage: type and categories
- Lecture 13 - Surface damage: Adhesive wear - I
- Lecture 14 - Surface damage: Adhesive wear - II
- Lecture 15 - Surface damage: Classical law of adhesive wear and abrasive wear
- Lecture 16 - Surface damage: Abrasive wear - I
- Lecture 17 - Surface damage: Abrasive wear - II
- Lecture 18 - Surface damage: Erosive wear
- Lecture 19 - Surface damage: Melting wear and corrosive wear
- Lecture 20 - Surface damage: Diffusive wear and evaluation of surface damage
- Lecture 21 - Properties and mode of wear
- Lecture 22 - Metal systems
- Lecture 23 - Thermal barrier coatings
- Lecture 24 - Functionally graded materials and other materials
- Lecture 25 - Surface modification techniques: Principle of controlling surface metallurgy
- Lecture 26 - Surface modification techniques: Controlling surface metallurgy - I
- Lecture 27 - Surface modification techniques: Controlling surface metallurgy - II
- Lecture 28 - Surface modification techniques: Controlling surface metallurgy - III
- Lecture 29 - Surface modification techniques: Controlling surface metallurgy - IV
- Lecture 30 - Surface modification techniques: Changing surface composition
- Lecture 31 - Surface modification techniques: Carburizing - I

Lecture 32 - Surface modification techniques: Carburizing - II

Lecture 33 - Surface modification techniques: Carburizing and Cyaniding

Lecture 34 - Surface modification techniques: Nitriding

Lecture 35 - Surface modification techniques: Plasma carburizing and plasma nitriding

Lecture 36 - Surface modification techniques: Vacuum based surface modification I

Lecture 37 - Surface modification techniques: Ion implantation and ion plating

Lecture 38 - Surface modification techniques: Sputtering and Ion beam assisted deposition

Lecture 39 - Surface modification techniques: Chemical vapour deposition and boronizing

Lecture 40 - Surface modification techniques: Laser alloying

Lecture 41 - Surface modification techniques: Laser nitriding and developing surface layer

Lecture 42 - Surface modification techniques: Fundamentals of surface modification by weld surfacing and thermal spraying

Lecture 43 - Surface modification techniques: Fundamentals of surface modification by weld surfacing

Lecture 44 - Surface modification techniques: Weld surfacing processes

Lecture 45 - Surface modification techniques: Weld surfacing - I

Lecture 46 - Surface modification techniques: Weld surfacing - II

Lecture 47 - Surface modification techniques: Weld surfacing - III

Lecture 48 - Surface modification techniques: Laser cladding

Lecture 49 - Surface modification techniques: Principle of thermal spraying

Lecture 50 - Surface modification techniques: Flame spraying

Lecture 51 - Surface modification techniques: Improving the performance of flame spray coating

Lecture 52 - Surface modification techniques: HVOF and Detonation spraying

Lecture 53 - Surface modification techniques: Cold spraying, arc spraying

Lecture 54 - Surface modification techniques: Plasma spraying, electroplating, electroless plating

Lecture 55 - Characterization of modified surfaces: Surface roughness and thickness - I

Lecture 56 - Characterization of modified surfaces: Surface roughness and thickness - II

Lecture 57 - Characterization of modified surfaces: Thickness and soundness

Lecture 58 - Characterization of modified surfaces: Soundness and mechanical properties

Lecture 59 - Characterization of modified surfaces: Metallography

Lecture 60 - Characterization of modified surfaces: Wear behavior

Lecture 1 - Work System Design: Introduction

Lecture 2 - Introduction and Concept of Productivity

Lecture 3 - Measurement of Productivity

Lecture 4 - Productivity Measures

Lecture 5 - Productivity Measurement Models

Lecture 6 - Factors Influencing Productivity

Lecture 7 - Causes of Low Productivity

Lecture 8 - Productivity Improvement Technique

Lecture 9 - Numerical Problems on Productivity

Lecture 10 - Case Study on Productivity

Lecture 11 - Work Study: Basic Concept

Lecture 12 - Steps Involved in Work Study

Lecture 13 - Concept of Work Content

Lecture 14 - Techniques of Work Study

Lecture 15 - Human Aspects of Work Study

Lecture 16 - Method Study: Basic Concept

Lecture 17 - Method Study: Steps

Lecture 18 - Method Study: Recording Techniques

Lecture 19 - Operation Process Charts

Lecture 20 - Operation Process Charts: Examples

Lecture 21 - Flow Process Charts

Lecture 22 - Flow Process Charts: Examples

Lecture 23 - Two-Handed-Process Charts

Lecture 24 - Multiple Activity Charts

Lecture 25 - Flow Diagrams

Lecture 26 - String Diagrams

Lecture 27 - Principles of Motion Economy

Lecture 28 - Micro-Motion Study

Lecture 29 - Therbligs

Lecture 30 - SIMO Charts

Lecture 31 - Memo-Motion Study

- Lecture 32 - Cycle Graph and Chronocycle Graph
- Lecture 33 - Critical Examination Techniques
- Lecture 34 - Development and Selection of New Method
- Lecture 35 - Installation and Maintenance of Improved Methods
- Lecture 36 - Work Measurement: Basic Concept
- Lecture 37 - Techniques of Work Measurement
- Lecture 38 - Steps Involved in Time Study
- Lecture 39 - Steps and Equipment of Time Study
- Lecture 40 - Performance Rating
- Lecture 41 - Performance Rating: Examples
- Lecture 42 - Allowances in Time Study
- Lecture 43 - Computation of Standard Time - I
- Lecture 44 - Computation of Standard Time - II
- Lecture 45 - Work Measurement: Applications
- Lecture 46 - Work Sampling: Basic Concept
- Lecture 47 - Procedure of Work Sampling
- Lecture 48 - Work Sampling: Examples
- Lecture 49 - Introduction to Synthetic Data and PMTS
- Lecture 50 - Introduction to MTM and MOST
- Lecture 51 - Ergonomics: Basic Concept
- Lecture 52 - Industrial Ergonomics
- Lecture 53 - Ergonomics: Anthropometry
- Lecture 54 - Man-Machine System - 1
- Lecture 55 - Man-Machine System - 2
- Lecture 56 - Case Study: Office Chair
- Lecture 57 - Case Study: Tower Crane Cabin
- Lecture 58 - Case Study: Car Seat
- Lecture 59 - Case Study: Computer System
- Lecture 60 - Case Study: Assembly Line

Lecture 1 - Introduction to Metal Forming Technology

Lecture 2 - Classification of Metal Working Processes

Lecture 3 - Behavior of Materials

Lecture 4 - Failure of Materials

Lecture 5 - Concept of stress and strain

Lecture 6 - Description of stress

Lecture 7 - State of stress in three dimension

Lecture 8 - Description of strain

Lecture 9 - Hydrostatic and deviator components of stress and strain

Lecture 10 - Elastic stress strain relationships

Lecture 11 - Introduction to theory of plasticity and flow curve

Lecture 12 - True stress and true strain

Lecture 13 - Yield criteria for ductile materials

Lecture 14 - Yield locus, Octahedral shear stress and strain

Lecture 15 - Plastic stress strain relationships

Lecture 16 - Measures of yielding and ductility in tensile testing

Lecture 17 - Instability in tension

Lecture 18 - Strain rate effects on flow properties

Lecture 19 - Temperature effects on flow properties

Lecture 20 - Influence of various parameters on flow properties

Lecture 21 - Classification of metal working processes

Lecture 22 - Mechanics of metalworking and analysis methods

Lecture 23 - Determination of flow stresses in metal working

Lecture 24 - Hot working and cold working

Lecture 25 - Metallurgical considerations in metal forming

Lecture 26 - Introduction and classification of forging processes

Lecture 27 - Equipments used in forging

Lecture 28 - Forging in plane strain

Lecture 29 - Introduction and classification of rolling processes

Lecture 30 - Analysis of rolling load calculations

Lecture 31 - Defects in rolled and forged products

[Lecture 32 - Introduction and classification of extrusion processes](#)

[Lecture 33 - Analysis of extrusion processes](#)

[Lecture 34 - Extrusion of tubes and pipes, extrusion defect](#)

[Lecture 35 - Introduction to rod and wire drawing](#)

[Lecture 36 - Analysis of wire drawing and tube drawing processes](#)

[Lecture 37 - Sheet metal operations - I](#)

[Lecture 38 - Sheet metal operations - II](#)

[Lecture 39 - Powder metallurgy forming - I](#)

[Lecture 40 - Powder metallurgy forming - II](#)

Lecture 1 - Introduction

Lecture 2 - Fundamentals of Radiation

Lecture 3 - Basic Laws of Thermal Radiation

Lecture 4 - Properties of Plane Surfaces

Lecture 5 - Radiative Properties of Materials

Lecture 6 - View Factor

Lecture 7 - Hottel Crossed String Method

Lecture 8 - Inside Sphere and Monte Carlo Method

Lecture 9 - Radiative Heat Exchange Between Black Surfaces

Lecture 10 - Radiative Heat Exchange Between Gray Diffuse Surfaces

Lecture 11 - Network Analogy

Lecture 12 - Solution Methods for Governing Integral Equations

Lecture 13 - Radiative Heat Exchange between Partially Specular Gray Surfaces

Lecture 14 - Non-Gray Surfaces

Lecture 15 - Radiative Heat Transfer in the Presence of Conduction/Convection

Lecture 16 - Radiative Transfer in Participating Media

Lecture 17 - Equation of Radiative Transfer

Lecture 18 - Solution of Radiative Transfer Equation

Lecture 19 - Radiative Heat Transfer in Cylindrical Media

Lecture 20 - Approximate Methods-I

Lecture 21 - Approximate Methods-II

Lecture 22 - The Method of Spherical Harmonics (PN Approximation) - I

Lecture 23 - The Method of Spherical Harmonics (PN Approximation) - II

Lecture 24 - Discrete Ordinate Method (DOM)

Lecture 25 - Zone Method

Lecture 26 - Exchange Areas

Lecture 27 - Monte Carlo Method for Thermal Radiation - I

Lecture 28 - Monte Carlo Method for Thermal Radiation - II

Lecture 29 - Radiative Properties of Gases

Lecture 30 - Atomic and Molecular Spectra

Lecture 31 - Line Radiation



[Lecture 32 - Spectral Modelling](#)

[Lecture 33 - Wide Band Models](#)

[Lecture 34 - WSGG Model](#)

[Lecture 35 - k-Distribution Model](#)

[Lecture 36 - Radiative Properties of Particulate Media](#)

[Lecture 37 - Combustion and Flame](#)

[Lecture 38 - Solar and Atmospheric Radiation](#)

[Lecture 39 - Concentrated Solar Collector](#)

[Lecture 40 - Experimental Methods](#)

Lecture 1 - Understanding Weldability: Introduction - I

Lecture 2 - Understanding Weldability: Introduction - II

Lecture 3 - Metal Properties and Weldability - I

Lecture 4 - Metal Properties and Weldability - II

Lecture 5 - Weldability of Work Hardenable Metals

Lecture 6 - Weldability of Work Hardenable and Precipitation Strengthened Metals

Lecture 7 - Weldability of Precipitation Strengthened Metals

Lecture 8 - Weldability of Metals Strengthened by Grain Refinement, dispersion Hardening and Transformation Hardening

Lecture 9 - Weldability of Transformation Hardening Metals

Lecture 10 - Weldability of Metals: Combination of Strengthening Mechanisms

Lecture 11 - Weldability Consideration

Lecture 12 - Weldability of Carbon and Alloy Steel - I

Lecture 13 - Weldability of Carbon and Alloy Steel - II

Lecture 14 - Weldability of Carbon and Alloy Steel - III

Lecture 15 - Weldability of Low Carbon Steel and Mild Steel

Lecture 16 - Weldability of Medium Carbon Steel and High Carbon Steel

Lecture 17 - Weldability of Carbon and Welding Processes - I

Lecture 18 - Weldability of Carbon and Welding Processes - II

Lecture 19 - Weldability of Carbon Steel and Welding Processes - III

Lecture 20 - Weldability of Carbon Steel and Radiation Welding and Thermal Cutting

Lecture 21 - Weldability of High Strength Low Alloy Steels

Lecture 22 - Weldability of Q&T Steels - I

Lecture 23 - Weldability of Q&T Steels - II

Lecture 24 - Weldability of Q&T Steels - III

Lecture 25 - Weldability of Q&T Steels - IV

Lecture 26 - Weldability of HTLA Steel - I

Lecture 27 - Weldability of HTLA Steel - II

Lecture 28 - Weldability of Cr-Mo Steel - I

Lecture 29 - Weldability of Cr-Mo Steel - II

Lecture 30 - Weldability of Cr-Mo Steel - III

Lecture 31 - Weldability of Pre-Coated Steel - I

[Lecture 32 - Weldability of Pre-Coated Steel - II](#)

[Lecture 33 - Weldability of Stainless Steel - I](#)

[Lecture 34 - Weldability of Stainless Steel - II](#)

[Lecture 35 - Weldability of Martensitic Stainless Steel - I](#)

[Lecture 36 - Weldability of Martensitic Stainless Steel - II](#)

[Lecture 37 - Weldability of Ferritic Stainless Steel - I](#)

[Lecture 38 - Weldability of Austenitic Stainless Steel - I](#)

[Lecture 39 - Weldability of Austenitic Stainless Steel - II](#)

[Lecture 40 - Weldability of PH Stainless Steel](#)

Lecture 1 - Product Design : Basics

Lecture 2 - Introduction of Manufacturing Processes

Lecture 3 - Manufacturing Processes : Advantages and Limitations - I

Lecture 4 - Manufacturing Processes : Advantages and Limitations - II

Lecture 5 - Process Capabilities : Basics

Lecture 6 - Engineering Materials

Lecture 7 - Properties of materials

Lecture 8 - Selection of materials - I

Lecture 9 - Selection of materials - II

Lecture 10 - Applications of Engineering Material

Lecture 11 - Robust design

Lecture 12 - Design for X

Lecture 13 - Product Design for Manual Assembly

Lecture 14 - DFMA Guidelines

Lecture 15 - Ergonomics in Product Design

Lecture 16 - Selection of processes - I

Lecture 17 - Selection of processes - II

Lecture 18 - Process Capabilities.

Lecture 19 - Design Guidelines for Sand Casting

Lecture 20 - Design Guidelines for Die Casting

Lecture 21 - Product Design Guidelines : Compression Molding and Extrusion

Lecture 22 - Design Guidelines for Extrusion and Injection Molding

Lecture 23 - Design Guidelines for Sheet Metal Working

Lecture 24 - Design Guidelines for Machining

Lecture 25 - Design Guidelines for Powder Metal Processing

Lecture 26 - Assembly Processes : Introduction

Lecture 27 - Adhesive Joining : Guidelines

Lecture 28 - Design Guidelines for Mechanical Fasteners

Lecture 29 - Design Guidelines for Welding

Lecture 30 - Design guidelines : Brazing and Soldering

Lecture 31 - Induction Welding : Plastics

[Lecture 32 - Ultrasonic Welding : Plastics](#)

[Lecture 33 - Vibration and Spin Welding : Plastics](#)

[Lecture 34 - Microwave Joining](#)

[Lecture 35 - Hole making : Guidelines](#)

[Lecture 36 - Design for Environment](#)

[Lecture 37 - Design for Environment : Steps](#)

[Lecture 38 - Product Architecture](#)

[Lecture 39 - Rapid Prototyping](#)

[Lecture 40 - Product Design : Manufacturing Perspective](#)

Lecture 1 - Introduction: Fundamental concepts of quality, inspection and their role in manufacturing

Lecture 2 - Need of Inspection: Types and Principles

Lecture 3 - Destructive Inspection - I

Lecture 4 - Destructive Inspection - II

Lecture 5 - Testing of Composite Materials

Lecture 6 - Nondestructive Inspection - Visual Inspection

Lecture 7 - Dye Penetrant Inspection

Lecture 8 - Magnetic Particle Inspection

Lecture 9 - Eddy Current Inspection

Lecture 10 - Ultrasonic Inspection

Lecture 11 - Acoustic Emission Inspection

Lecture 12 - Radiography Inspection

Lecture 13 - Leak Testing

Lecture 14 - Thermographic Nondestructive Testing

Lecture 15 - Advanced Nondestructive Testing Techniques, NDT Standards, Safety in NDT

Lecture 16 - Engineering Metrology - Linear Measurement

Lecture 17 - Angular Measurement and Measurement of Surface Finish

Lecture 18 - Screw Thread Metrology

Lecture 19 - Gear Measurement

Lecture 20 - Miscellaneous Measurements

Lecture 1 - Introduction to Financial Mathematics

Lecture 2 - Important Mathematical Functions and its Characteristics

Lecture 3 - Progressions and Series, Growth and Decay Curves

Lecture 4 - Statistical Measures

Lecture 5 - Problem Solving on Mathematical Functions and Statistical Measures

Lecture 6 - Interest and Interest Rate, Time Value of Money

Lecture 7 - Simple Discount, Focal Date and Equation of Value

Lecture 8 - Introduction to Bank Discount

Lecture 9 - Introduction to Compound Interest

Lecture 10 - Problem Solving on Simple Interest and Bank Discount

Lecture 11 - Introduction to Discrete Compounding and Discrete Payments

Lecture 12 - Equal Payment Series and Gradient Series Factors

Lecture 13 - Geometric Gradient Series Factors

Lecture 14 - Annuities Due and Annuities Deferred

Lecture 15 - Problem Solving on Compounding Factors

Lecture 16 - Compounding Frequency of Interest

Lecture 17 - Interest Factors for Continuous Compounding

Lecture 18 - Introduction to Economic Equivalence

Lecture 19 - Principles of Equivalence

Lecture 20 - Problem Solving on Compounding Frequency and Economic Equivalence

Lecture 21 - Methods of Comparison of Alternatives

Lecture 22 - Payback Period

Lecture 23 - Capitalized Equivalent and Capital Recovery with Return

Lecture 24 - Project Balance

Lecture 25 - Problem Solving on Alternatives Comparison and Project Balance

Lecture 26 - Analysis of Credit and Loans

Lecture 27 - Assessing Interest and Structured Payments in Loans

Lecture 28 - Introduction to Cost of Credit and Amortization

Lecture 29 - Analysis of Amortization Schedule

Lecture 30 - Graduated Payment Mortgage, Sinking Funds

Lecture 31 - Introduction to Depreciation and Depletion

Lecture 32 - Types of Depreciation: SL Method and Declining Balance Method

Lecture 33 - Tax Depreciation Methods

Lecture 34 - SOD and UOP Method of Depreciation, Depletion

Lecture 35 - Problem Solving on Depreciation and Depletion

Lecture 36 - Introduction to Break-Even Analysis

Lecture 37 - Analysis of Break-Even Time and Dual Break-Even Points

Lecture 38 - Economic Order Quantity

Lecture 39 - Introduction to Leverage

Lecture 40 - Financial Leverage and Total Leverage

Lecture 41 - Introduction to Stocks

Lecture 42 - Stock Valuation

Lecture 43 - Two Stage Dividend Growth and Preferred Stocks

Lecture 44 - Introduction to Bonds

Lecture 45 - Bond Premium and Discount, Bond Purchase

Lecture 46 - Introduction to Mutual funds

Lecture 47 - Performance Measures

Lecture 48 - Options

Lecture 49 - Option Valuation

Lecture 50 - Introduction to Cost of Capital and Ratio Analysis

Lecture 51 - Introduction to Risk Measurement

Lecture 52 - Decision-Making Under Risk

Lecture 53 - Decision Under Uncertainty

Lecture 54 - Risk Premium, Portfolio Return and Risk

Lecture 55 - Portfolio Diversification

Lecture 56 - Introduction to Insurance, Mortality Table

Lecture 57 - Pure Endowment and Life Annuities

Lecture 58 - Introduction to Life Insurance

Lecture 59 - Types of Life Insurance Policies

Lecture 60 - Reserve Funds, Property and Casualty Insurance



- Lecture 1 - Introduction to Product Design and Development
- Lecture 2 - Product Design Steps and Product Analysis
- Lecture 3 - Profit Consideration
- Lecture 4 - Value Engineering (VE) History, Concept and Definitions
- Lecture 5 - Value Engineering vs Cost Cutting
- Lecture 6 - Creative Thinking
- Lecture 7 - Problem Identification and VEJP
- Lecture 8 - Types of Product Functions
- Lecture 9 - Funtional Analysis
- Lecture 10 - Functional Analysis System Technique
- Lecture 11 - Function-Cost Relationship - I
- Lecture 12 - Function-Cost Relationship - II
- Lecture 13 - VE Applications in Product Design
- Lecture 14 - Value Engineering: Case Study - I
- Lecture 15 - Value Engineering: Case Study - II
- Lecture 16 - VE Tools and Techniques - I
- Lecture 17 - VE Tools and Techniques - II
- Lecture 18 - VE Success Stories - I
- Lecture 19 - VE Success Stories - II
- Lecture 20 - Behavioral Roadblocks

Lecture 1 - Introduction

Lecture 2 - Solar Energy Harvesting

Lecture 3 - Perovskite Solar Cells

Lecture 4 - Solar Thermal Energy

Lecture 5 - Heat Transfer Fluids

Lecture 6 - Hydrogen Energy: Introduction and Hydrogen Production from Fossil Fuels and Biomass

Lecture 7 - Hydrogen Production from Thermochemical Process

Lecture 8 - Hydrogen Production from Electrolysis

Lecture 9 - Photo-electrochemical Production of Hydrogen Using Solar Energy

Lecture 10 - Hydrogen Production from Biological Process

Lecture 11 - Nanogenerators: Introduction and Piezoelectric Nanogenerators

Lecture 12 - Triboelectric Nanogenerators

Lecture 13 - Pyroelectric Nanogenerators

Lecture 14 - Thermoelectric Nanogenerators and Electromagnetic generators

Lecture 15 - Other Energy Resources

Lecture 16 - Energy Storage

Lecture 17 - Electrochemical Energy Storage (Batteries)

Lecture 18 - Supercapacitors

Lecture 19 - Hydrogen Storage

Lecture 20 - Thermal Energy Storage

Lecture 1 - Introduction

Lecture 2 - Coordinate Frames and Homogeneous Transformations - I

Lecture 3 - Coordinate Frames and Homogeneous Frames - II

Lecture 4 - Differential Transformations

Lecture 5 - Transforming Differential Changes between Coordinate Frames

Lecture 6 - Kinematic Model for Robot Manipulator

Lecture 7 - Direct Kinematics

Lecture 8 - Inverse Kinematics

Lecture 9 - Manipulator Jacobian

Lecture 10 - Manipulator Jacobian Example

Lecture 11 - Trajectory Planning

Lecture 12 - Dynamics of Manipulator

Lecture 13 - Dynamics of Manipulator (Continued...)

Lecture 14 - Manipulator Dynamics Multiple Degree of Freedom

Lecture 15 - Stability of Dynamical System

Lecture 16 - Manipulator Control

Lecture 17 - Biped Robot Basics and Flat Foot Biped Model

Lecture 18 - Biped Robot Flat Foot and Toe Foot Model

Lecture 19 - Artificial Neural Network

Lecture 20 - Neural Network based control for Robot Manipulator

Lecture 21 - Redundancy Resolution of Human Fingers in Cooperative Object Translation - I

Lecture 22 - Redundancy Resolution of Human Fingers in Cooperative Object Translation - II

Lecture 23 - Fundamentals of Robot Manipulability

Lecture 24 - Manipulability Analysis of Human Fingers in Cooperative Rotational Motion

Lecture 25 - Robotic Exoskeletons: An Introduction

Lecture 26 - Introduction to Robotic Hand Exoskeleton

Lecture 27 - Design and Development of a Three Finger Exoskeleton

Lecture 28 - Force Control of an Index Finger Exoskeleton

Lecture 29 - Neural Control of a Hand Exoskeleton

Lecture 30 - Neural Control of a Hand Exoskeleton Based on Human Subject's Intention

Lecture 31 - Robot Assisted Percutaneous Interventions

[Lecture 32 - Experiments on Robot Assisted Percutaneous Interventions](#)

[Lecture 33 - Sliding Mode Control](#)

[Lecture 34 - Higher Order Sliding Mode Control](#)

[Lecture 35 - Smart Needles for Percutaneous Interventions - I](#)

[Lecture 36 - Smart Needles for Percutaneous Interventions - II](#)

[Lecture 37 - Flexible Link Kinematics - I](#)

[Lecture 38 - Flexible Link Kinematics - II](#)

[Lecture 39 - Model Based Control of Robot Manipulators](#)

[Lecture 40 - Simulation of Robot Manipulators](#)

Lecture 1 - Introduction

Lecture 2 - Sound Wave Propagation in Fluid - I

Lecture 3 - Sound Wave Propagation in Fluid - II

Lecture 4 - Sound Wave Propagation in Fluid - III

Lecture 5 - Sound Propagation at Medium Boundaries - I

Lecture 6 - Sound Propagation at Medium Boundaries - II

Lecture 7 - Standing Waves and Modes

Lecture 8 - Sound Signal Analysis - I

Lecture 9 - Sound Signal Analysis - II

Lecture 10 - Principles of Noise Control

Lecture 11 - Acoustic Materials

Lecture 12 - Enclosures

Lecture 13 - Barriers

Lecture 14 - Enclosures and Barriers - Tutorial

Lecture 15 - Sound Absorbing Materials

Lecture 16 - Porous-Fibrous Sound Absorbers

Lecture 17 - Panel Sound Absorbers

Lecture 18 - Helmholtz Resonators

Lecture 19 - Tutorial on Sound Absorbers

Lecture 20 - Perforated Panel Absorbers

Lecture 21 - Microperforated Panel Absorbers - 1

Lecture 22 - Microperforated Panel Absorbers - 2

Lecture 23 - Microperforated Panel Absorbers - 3

Lecture 24 - Introduction to Acoustic Metamaterials - 1

Lecture 25 - Introduction to Acoustic Metamaterials - 2

Lecture 26 - History of Acoustic Metamaterials

Lecture 27 - Applications of Acoustic Metamaterials

Lecture 28 - Membrane Type Acoustic Metamaterials - 1

Lecture 29 - Membrane Type Acoustic Metamaterials - 2

Lecture 30 - Membrane Type Acoustic Metamaterials - 3

Lecture 31 - Membrane Type Acoustic Metamaterials - 4

[Lecture 32 - Advantages and Applications of Membrane Type AMM](#)

[Lecture 33 - Tutorial on Membrane Type AMM](#)

[Lecture 34 - Introduction to Sonic Crystals](#)

[Lecture 35 - Fundamentals of Crystals](#)

[Lecture 36 - Principle of Working of Sonic Crystals - 1](#)

[Lecture 37 - Principle of Working of Sonic Crystals - 2](#)

[Lecture 38 - Tutorial on Sonic Crystals](#)

[Lecture 39 - More on Sonic Crystals and Conclusions](#)

Lecture 1 - Energy Scenario and Basic Concepts

Lecture 2 - Steam Power Plant Cycle

Lecture 3 - Fossil Fuel Steam Generator - I

Lecture 4 - Fossil Fuel Steam Generator - II

Lecture 5 - Mountings and Accessories - I

Lecture 6 - Mountings and Accessories - II

Lecture 7 - Boiler Performance

Lecture 8 - Coal Properties

Lecture 9 - Coal Handling

Lecture 10 - Problem Solving - I

Lecture 11 - Burning of Fuel

Lecture 12 - Ash Handling

Lecture 13 - Feed Water Treatment

Lecture 14 - Steam Turbines

Lecture 15 - Impulse Steam Turbines

Lecture 16 - Impulse-Reaction Steam Turbines

Lecture 17 - Energy Losses in Steam Turbines

Lecture 18 - Steam Condensers

Lecture 19 - Gas Turbines

Lecture 20 - Problem Solving - II

Lecture 21 - Hydroelectric power plant

Lecture 22 - Hydro plants and forces on plates

Lecture 23 - Hydro Turbines - I

Lecture 24 - Hydro Turbines - II

Lecture 25 - Problem solving - III

Lecture 26 - Principles of nuclear energy

Lecture 27 - Nuclear power plants - I

Lecture 28 - Nuclear power plants - II

Lecture 29 - Combined operations

Lecture 30 - Solar radiations

Lecture 31 - Solar thermal power

[Lecture 32 - Wind energy](#)

[Lecture 33 - Wave and geothermal energy](#)

[Lecture 34 - Photo-voltaic conversion](#)

[Lecture 35 - Problem solving - IV](#)

[Lecture 36 - Direct energy conversion](#)

[Lecture 37 - Instrumentation in power plant](#)

[Lecture 38 - Economic of power generation](#)

[Lecture 39 - Environmental aspects of power generation](#)

[Lecture 40 - Problem solving - V](#)



Lecture 1 - Introduction

Lecture 2 - Introduction: Developments, Objectives, and Functions

Lecture 3 - Introduction: Functions and Tools

Lecture 4 - Tool of IE and Organizational Structure

Lecture 5 - Organisational Structure

Lecture 6 - Organizational Structure: Roles

Lecture 7 - Organizational Structure: Types

Lecture 8 - Organizational Structure: Product Strategies

Lecture 9 - Organizational Structure: Process and Product Organization

Lecture 10 - Organizational Structure and Culture

Lecture 11 - Organizational Structure: Principles

Lecture 12 - Plant Location and Layout: Selection of Site

Lecture 13 - Plant Location and Layout: Factor Affecting Selection of Site

Lecture 14 - Plant Location and Layout: Methods for Selection of Site - I

Lecture 15 - Plant Location and Layout: Methods for Selection of Site - II

Lecture 16 - Plant Location and Layout: Methods for Selection of Site - III

Lecture 17 - Plant Location and Layout: Methods for Selection of Site - IV

Lecture 18 - Plant Layout: Purpose and Types of Layout

Lecture 19 - Plant Layout: Types of Layout

Lecture 20 - Plant Layout: Cellular and Process Layout

Lecture 21 - Plant Layout: Process Layout Design - I

Lecture 22 - Plant Layout: Process Layout Design - II

Lecture 23 - Plant Layout: Product Layout Design

Lecture 24 - Organization of Facility

Lecture 25 - Organization of Facility and Material Handling

Lecture 26 - Material Handling

Lecture 27 - Production Planning and Control: Scope - I

Lecture 28 - Production Planning and Control: Scope - II

Lecture 29 - Production Planning and Control: Capacity Planning

Lecture 30 - Production Planning and Control: Capacity Planning and Scheduling

Lecture 31 - Production Planning and Control: MRP, Routing, Scheduling

- Lecture 32 - Production Planning and Control: Scheduling
- Lecture 33 - Production Planning and Control: Priority Sequencing - I
- Lecture 34 - Production Planning and Control: Priority Sequencing - II
- Lecture 35 - Production Planning and Control: Relative Performance of Priority Sequencing Rules
- Lecture 36 - Inventory: Fundamentals
- Lecture 37 - Inventory: Models - I
- Lecture 38 - Inventory: Models - II
- Lecture 39 - Inventory: Wilson Model
- Lecture 40 - Inventory: Gradual Replenishment Model
- Lecture 41 - Project Management and Network Modelling: Introduction
- Lecture 42 - Network Modelling: PERT
- Lecture 43 - Network Analysis: PERT - I
- Lecture 44 - Network Analysis: PERT - II
- Lecture 45 - Network Analysis: Crashing Network and CPM
- Lecture 46 - Network Analysis: Critical Path Method
- Lecture 47 - Forecasting: Introduction
- Lecture 48 - Forecasting: Methods - I
- Lecture 49 - Forecasting: Methods - II
- Lecture 50 - Forecasting: Methods - III
- Lecture 51 - Forecasting: Methods - IV
- Lecture 52 - Forecasting: Methods - V
- Lecture 53 - Quality Control: Introduction
- Lecture 54 - Quality Control: Fundamentals
- Lecture 55 - Quality Control: SPC - I
- Lecture 56 - Quality Control: SPC - II
- Lecture 57 - Quality Control: Control Charts - I
- Lecture 58 - Quality Control: Control Charts - II
- Lecture 59 - Quality Control: Control Charts for Attributes
- Lecture 60 - Productivity and Work Study

Lecture 1 - Introduction

Lecture 2 - Mechatronics System Examples

Lecture 3 - Electric Circuits and Components

Lecture 4 - Semiconductor Electronics

Lecture 5 - Application of Transistors

Lecture 6 - Sensors Performance Terminology

Lecture 7 - Displacement, Position and Proximity Sensors - I

Lecture 8 - Displacement, Position and Proximity Sensors - II

Lecture 9 - Force, Fluid Flow Sensors

Lecture 10 - Acceleration and Vibration Measurement Sensors

Lecture 11 - Mechanical Actuation Systems

Lecture 12 - Hydraulic and Pneumatic Actuators

Lecture 13 - Electrical Actuation Systems - I

Lecture 14 - Electrical Actuation Systems - II

Lecture 15 - Data Presentation Systems

Lecture 16 - Introduction to Signal Conditioning and Op-Amp

Lecture 17 - OP-AMP As Signal Conditioner

Lecture 18 - Analogue To Digital Converters

Lecture 19 - Digital To Analogue Converters

Lecture 20 - Artificial Intelligence

Lecture 21 - Digital Circuits - I

Lecture 22 - Digital Circuits - II

Lecture 23 - Microprocessor

Lecture 24 - Microcontroller

Lecture 25 - Microcontroller Programming Example

Lecture 26 - Mechanical System Model

Lecture 27 - Electrical System Model

Lecture 28 - Fluid System Model

Lecture 29 - Dynamic Response of Systems

Lecture 30 - Transfer Function and Frequency Response

Lecture 31 - Controllers

[Lecture 32 - Digital Controllers](#)

[Lecture 33 - Program Logic Controllers](#)

[Lecture 34 - Input, output and Communication systems](#)

[Lecture 35 - Fault Finding](#)

[Lecture 36 - Project using Microcontroller - ATMEGA16](#)

[Lecture 37 - Myoelectrically Controlled Robotic Arm](#)

[Lecture 38 - ABU Robocon 2019 - Part I](#)

[Lecture 39 - ABU Robocon 2019 - Part II](#)

[Lecture 40 - Design of a Legged Robot](#)

Lecture 1 - Course outline

Lecture 2 - Vectorial representation of forces and moments

Lecture 3 - Couple moment and reduction of a force system to a force and a couple

Lecture 4 - Examples of couple moment

Lecture 5 - Examples: moment in three dimensions

Lecture 6 - Free body diagram and support reactions

Lecture 7 - Equilibrium of rigid bodies in two and three dimensions

Lecture 8 - Examples: Equilibrium of rigid bodies in two dimensions

Lecture 9 - Examples: Equilibrium of rigid bodies in three dimensions

Lecture 10 - Examples: Beams and distributed loads

Lecture 11 - Flexible Cable

Lecture 12 - Flexible Cable, Catenary curve

Lecture 13 - Examples: Parabolic and Catenary cables

Lecture 14 - Flexible Cable: Concentrated load

Lecture 15 - Structures: Plane Trusses

Lecture 16 - Analysis of trusses: Method of joints

Lecture 17 - Analysis of trusses: Method of sections

Lecture 18 - Shear force and bending moment

Lecture 19 - Shear force and bending moment: distributed load

Lecture 20 - Principle of virtual work

Lecture 21 - Principle of virtual work: examples - I

Lecture 22 - Principle of virtual work: examples - II

Lecture 23 - Stable and unstable equilibrium

Lecture 24 - Friction

Lecture 25 - Friction: examples

Lecture 26 - Rope and belt friction

Lecture 27 - Rope and belt friction: examples

Lecture 28 - Rolling resistance

Lecture 29 - Revision: static

Lecture 30 - Coordinate systems: Cartesian and planar polar coordinates

Lecture 31 - Coordinate systems: spherical coordinates

- Lecture 32 - Coordinate systems: cylindrical coordinates
- Lecture 33 - Cartesian and planar polar coordinates: examples
- Lecture 34 - Spherical and cylindrical coordinates: examples
- Lecture 35 - Equation of motion in different coordinate systems
- Lecture 36 - Equation of motion: examples
- Lecture 37 - Work energy method
- Lecture 38 - Work energy method: examples
- Lecture 39 - Impulse momentum relation
- Lecture 40 - Variable mass
- Lecture 41 - Direct central impact
- Lecture 42 - Oblique central impact
- Lecture 43 - Moment of inertia
- Lecture 44 - Moment of inertia: examples
- Lecture 45 - Moment of inertia of composite bodies
- Lecture 46 - Product of inertia and principal axes of inertia
- Lecture 47 - Principal axes of inertia: examples - I
- Lecture 48 - Principal axes of inertia: examples - II
- Lecture 49 - Harmonic oscillator: simple harmonic motion
- Lecture 50 - Simple harmonic motion: examples
- Lecture 51 - Damped harmonic oscillator
- Lecture 52 - Translation and rotation of rigid bodies
- Lecture 53 - Translation and rotation of rigid bodies: examples
- Lecture 54 - Plane motion of a rigid body
- Lecture 55 - Plane motion of a rigid body: work energy equation
- Lecture 56 - Plane motion of a rigid body: impulse-momentum equation
- Lecture 57 - Three-dimensional dynamics of rigid bodies: angular momentum
- Lecture 58 - Euler's equations of motion
- Lecture 59 - Euler's equations of motion: examples
- Lecture 60 - Revision: Dynamics

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

## NPTEL : Micro and Smart Systems (Mechanical Engineering)

**Co-ordinators : Dr. K.J. Vinoy, Prof. S. Gopalakrishnan, Prof. K.N. Bhat, Prof. G.K. Anathasuresh**

Lecture 1 - Glimpses of Microsystems: Scaling Effects

Lecture 2 - Smart Materials and Systems

Lecture 3 - Microsensors

Lecture 4 - Microactuators

Lecture 5 - Microsystems: some Examples

Lecture 6 - Smart systems Application and Structural Health Monitoring

Lecture 7 - Microfabrication Technologies

Lecture 8 - Thin-film Materials and their Deposition

Lecture 9 - Approaches for Pattern Transfer

Lecture 10 - Surface Micromachining of Microstructures

Lecture 11 - Bulk Micromachining of Microsystems

Lecture 12 - Extended Approaches for Working Microsystems

Lecture 13 - Non-conventional Approaches for Microsystems

Lecture 14 - Packaging of Microsystems

Lecture 15 - Deformation Strains and Stresses

Lecture 16 - Microdevice Suspensions: Lumped Modeling

Lecture 17 - Residual Stress and Stress Gradients

Lecture 18 - Torsion and Twist

Lecture 19 - Vibrations of Microsystems Devices: Part-1

Lecture 20 - Vibrations of Microsystems Devices: Part-2 Micromachined Gyroscopes: Part-1

Lecture 21 - Micromachined Gyroscopes: Part-2 Modelling of Coupled Electrostatic Microsystems: Part-1

Lecture 22 - Modelling of Coupled Electrostatic Microsystems: Part-2

Lecture 23 - Coupled Electrothermal-elastic Modelling

Lecture 24 - Modelling of Microsystems: Scaling Effects

Lecture 25 - Finite Element Method and Microsystems

Lecture 26 - Theoretical Basis for the Finite Element Method

Lecture 27 - Energy Theorems and Weak Form of the Governing Equation

Lecture 28 - Finite Element Equation Development and Shape Functions

Lecture 29 - Isoparametric FE Formulation and some Examples

Lecture 30 - Finite Element for Structures with Piezoelectric Materials

Lecture 31 - Semiconductor Device Physics

[Lecture 32 - BJT and MOSFET Characteristics and Op-Amps](#)

[Lecture 33 - Op-Amp Circuits and Signal conditioning for Microsystems Devices](#)

[Lecture 34 - Control and Microsystems](#)

[Lecture 35 - Vibration Control of a Beam](#)

[Lecture 36 - Signal Conditioning Circuits and Integration of Microsystems and Microelectronics](#)

[Lecture 37 - Pressure Sensor Design Concepts, Processing, and Packaging: Part-1](#)

[Lecture 38 - Pressure Sensor Design Concepts, Processing, and Packaging: Part-2](#)

[Lecture 39 - Pressure Sensor Design Concepts, Processing, and Packaging: Part-3 Capacitive Micro-accelerometer: Part-1](#)

[Lecture 40 - Capacitive Micro-accelerometer: Part-2](#)



Lecture 1 - Classification of optimization problems and the place of Calculus of Variations in it - Part I

Lecture 2 - Classification of optimization problems and the place of Calculus of Variations in it - Part II

Lecture 3 - Genesis of Calculus of Variations - Part I

Lecture 4 - Genesis of Calculus of Variations - Part II

Lecture 5 - Formulation of Calculus of Variations problems in geometry and mechanics and design - Part I

Lecture 6 - Formulation of Calculus of Variations problems in geometry and mechanics and design - Part II

Lecture 7 - Unconstrained minimization in one and many variables - Part I

Lecture 8 - Unconstrained minimization in one and many variables - Part II

Lecture 9 - Constrained minimization KKT conditions - Part I

Lecture 10 - Constrained minimization KKT conditions - Part II

Lecture 11 - Sufficient conditions for constrained minimization - Part I

Lecture 12 - Sufficient conditions for constrained minimization - Part II

Lecture 13 - Mathematical preliminaries function, functional, metrics and metric space, norm and vector spaces - Part I

Lecture 14 - Mathematical preliminaries function, functional, metrics and metric space, norm and vector spaces - Part II

Lecture 15 - Function spaces and Gateaux variation

Lecture 16 - First variation of a functional Frechet differential and variational derivative

Lecture 17 - Fundamental lemma of calculus of variations and Euler Lagrange equations - Part I

Lecture 18 - Fundamental lemma of calculus of variations and Euler Lagrange equations - Part II

Lecture 19 - Extension of Euler-Lagrange equations to multiple derivatives

Lecture 20 - Extension of Euler-Lagrange equations to multiple functions in a functional

Lecture 21 - Global Constraints in calculus of variations - Part I

Lecture 22 - Global Constraints in calculus of variations - Part II

Lecture 23 - Local (finite subsidiary) constraints in calculus of variations - Part I

Lecture 24 - Local (finite subsidiary) constraints in calculus of variations - Part II

Lecture 25 - Size optimization of a bar for maximum stiffness for given volume - Part I

Lecture 26 - Size optimization of a bar for maximum stiffness for given volume - Part II

Lecture 27 - Size optimization of a bar for maximum stiffness for given volume - Part III

Lecture 28 - Calculus of variations in functionals involving two and three independent variables - Part I

Lecture 29 - Calculus of variations in functionals involving two and three independent variables - Part II

Lecture 30 - General variation of a functional, transversality conditions. Broken extremals, Weierstrass-Erdmann corner conditions - Part I

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Lecture 31 - General variation of a functional, transversality conditions. Broken extremals, Wierstrass-Erdmann corner conditions - Part II

Lecture 32 - Variational (energy) methods in statics; principles of minimum potential energy and virtual work

Lecture 33 - General framework of optimal structural designs - Part I

Lecture 34 - General framework of optimal structural designs - Part II

Lecture 35 - Optimal structural design of bars and beams using the optimality criteria method

Lecture 36 - Invariants of Euler-Lagrange equations and canonical forms

Lecture 37 - Noether's theorem

Lecture 38 - Minimum characterization of Sturm-Liouville problems

Lecture 39 - Rayleigh quotient for natural frequencies and mode shapes of elastic systems

Lecture 40 - Stability analysis and buckling using calculus of variations

Lecture 41 - Strongest (most stable) column

Lecture 42 - Dynamic compliance optimization

Lecture 43 - Electro-thermal-elastic structural optimization

Lecture 44 - Formulating the extremization problem starting from the differential equation, self-adjointness of the differential operator, and methods to deal with conservative and dissipative system

Lecture 1 - Overview

Lecture 2 - Spirit of compliant design

Lecture 3 - A glimpse of applications

Lecture 4 - Mobility and degrees of freedom in compliant mechanisms

Lecture 5 - Maxwell's rule and Grubler's formula

Lecture 6 - Using compatibility and force equilibrium matrices to identify degrees of freedom and states of self-stress in trusses

Lecture 7 - Empirical formula for flexure joints

Lecture 8 - Types of elastic pairs (flexures)

Lecture 9 - Linear finite element analysis of compliant mechanisms with beam elements

Lecture 10 - A compliant mechanism kit

Lecture 11 - Linear and nonlinear finite element analyses using continuum elements

Lecture 12 - Subtleties in finite element analysis: geometric nonlinearity and contact

Lecture 13 - Deformation of a cantilever under a tip-load, using elliptic integrals

Lecture 14 - Elliptic integrals and their use in elastica analysis

Lecture 15 - Frisch-Fay's approach to large deformation of beam

Lecture 16 - Burns-Crossley's kinematic model

Lecture 17 - Howell-Midha's elastic model

Lecture 18 - Putting together the pseudo rigid-body model

Lecture 19 - Modeling a partially compliant mechanism

Lecture 20 - Kinematic coefficients of a four-bar linkage with and without springs

Lecture 21 - Solving equations of PRB modeling and comparing with finite element analysis

Lecture 22 - Loop-closure equations for PRB models of compliant mechanisms

Lecture 23 - Burmester theory for compliant mechanisms

Lecture 24 - PRB-based Synthesis Examples

Lecture 25 - Structural optimization approach

Lecture 26 - Early works on design for compliance

Lecture 27 - Design for deflection of trusses

Lecture 28 - Design for deflection of beams and frames

Lecture 29 - Design of elastic continua for desired deflection

Lecture 30 - Continuum element-based topology optimization of compliant mechanisms

Lecture 31 - YinSyn; synthesis of nonlinear responses with compliant mechanisms

Lecture 32 - Five different formulations for compliant mechanism design and some benchmark problems

Lecture 33 - Distributed compliance

Lecture 34 - How to achieve distributed compliance

Lecture 35 - Shape optimization

Lecture 36 - Cam-flexure clamp-case-study

Lecture 37 - SL model for compliant mechanisms

Lecture 38 - Feasibility maps for compliant mechanisms

Lecture 39 - Selection of compliant mechanisms for given user-specifications

Lecture 40 - Two case-studies using feasibility maps technique

Lecture 41 - SML model for compliant mechanisms for dynamic response

Lecture 42 - Re-design of compliant mechanisms; Matlab and Java codes

Lecture 43 - Non-dimensional analysis of beams

Lecture 44 - Deformation index and slenderness ratio of compliant mechanisms

Lecture 45 - Kinetoelastostatic maps

Lecture 46 - Designing with kinetoelastic maps

Lecture 47 - Non-dimensionalization of stress, frequency, and other measures

Lecture 48 - Designing compliant suspensions using kinetoelastic maps

Lecture 49 - Instant centre method for designing compliant mechanisms

Lecture 50 - Stiffness and compliance ellipsoids

Lecture 51 - Building block method of designing compliant mechanisms

Lecture 52 - Comparative analysis of different methods for designing compliant mechanisms

Lecture 53 - Aspects of Mechanical advantage of compliant mechanisms

Lecture 54 - Mechanical advantage of rigid-body and compliant mechanisms

Lecture 55 - Bistability in elastic systems

Lecture 56 - Analysis of bistable arches

Lecture 57 - Compliant mechanisms with bistable arches

Lecture 58 - Static balancing and zero-free-length springs

Lecture 59 - Static balance of a compliant mechanism using a linkage

Lecture 60 - Static balancing method for compliant mechanisms

Lecture 61 - A catalogue of compliant mechanisms

Lecture 62 - Compliant suspension mechanism in microsystems (MEMS)

Lecture 63 - Micromechanical signal processors using compliant mechanisms

Lecture 64 - A few special concepts of compliant mechanisms

[Lecture 65 - Materials and prototyping of compliant mechanisms](#)

[Lecture 66 - Summary of the course](#)

[Lecture 67 - Micromachined accelerometers with Displacement-amplifying Compliant Mechanisms \(DaCMs\)](#)

[Lecture 68 - Miniature compliant mechanisms as cell-manipulation tools](#)

[Lecture 69 - Micro-newton force sensor](#)

[Lecture 70 - Compliant tissue cutting mechanism](#)

[Lecture 71 - A compliant pipe-crawling robots](#)

[Lecture 72 - A compliant easy-chair for the elderly](#)

Lecture 1 - Introduction to Multiphase

Lecture 2 - Thermodynamics of Multiphase systems

Lecture 3 - Thermodynamics of Interface - I

Lecture 4 - Thermodynamics of Interface - II

Lecture 5 - Interfacial phenomena key concepts - I

Lecture 6 - Interfacial phenomena key concepts - II

Lecture 7 - Interfacial heat and mass transfer - I - Interfacial mass, momentum and energy balance, Surface tension, WettingL07

Lecture 8 - Interfacial heat and mass transfer - II - Interfacial dynamics, Instabilities of the interface

Lecture 9 - Interfacial heat and mass transfer - III - Evaporation from thin films

Lecture 10 - Governing equations and interfacial conditions

Lecture 11 - Governing equations : Averaging techniques - I

Lecture 12 - Governing equations : Averaging techniques - II

Lecture 13 - Governing equations : Averaging techniques - III

Lecture 14 - Interface shapes

Lecture 15 - Transport processes at interface with key concepts - I

Lecture 16 - Transport processes at interface with key concepts - II

Lecture 17 - Interfacial transport

Lecture 18 - Interfacial transport including dynamic behavior

Lecture 19 - Interface behavior

Lecture 20 - Heat transfer and evaporation in droplets

Lecture 21 - Droplet vaporization models - I

Lecture 22 - Droplet vaporization models - II

Lecture 23 - Droplet vaporization dynamics - I

Lecture 24 - Droplet vaporization dynamics - II

Lecture 25 - Droplet liquid phase transport

Lecture 26 - Comprehensive droplet vaporization model and correlations - I

Lecture 27 - Comprehensive droplet vaporization model and correlations - II

Lecture 28 - Comparison of droplet vaporization models

Lecture 29 - Species transport in droplet

Lecture 30 - Heat transfer and transport processes in sessile droplets

Lecture 31 - Introduction to atomization

[Lecture 32 - Atomization principles and governing parameters](#)

[Lecture 33 - Spray / droplet breakup models  \$\hat{A}\$ - I \(TAB model\)](#)

[Lecture 34 - Spray / droplet breakup models  \$\hat{A}\$ - II \(WAVE model\)](#)

[Lecture 35 - Droplet combustion - I](#)

[Lecture 36 - Droplet combustion - II](#)

[Lecture 37 - Regimes in spray combustion](#)

[Lecture 38 - Boiling - I](#)

[Lecture 39 - Boiling - II \(Bubble dynamics\)](#)

[Lecture 40 - Boiling - II \(Bubble dynamics and critical heat flux\)](#)

- Lecture 1 - Introduction to convective heat transfer
- Lecture 2 - Governing equations I - Momentum Conservation
- Lecture 3 - Governing equations II - Energy Conservation
- Lecture 4 - Introduction to external forced convection
- Lecture 5 - Scaling Analysis - Momentum
- Lecture 6 - Scaling Analysis - Energy I
- Lecture 7 - Scaling Analysis - Energy II
- Lecture 8 - Similarity solution - Momentum
- Lecture 9 - Similarity solution - Energy
- Lecture 10 - Integral solutions - Momentum
- Lecture 11 - Integral solutions - Energy
- Lecture 12 - Suction and Blowing
- Lecture 13 - Falkner-Skan solution
- Lecture 14 - Arbitrary Wall temperature
- Lecture 15 - Internal forced convection - Developing flow
- Lecture 16 - Hydrodynamic fully developed flow
- Lecture 17 - Mean temperature in fully developed flow
- Lecture 18 - Uniform heat flux
- Lecture 19 - Uniform wall temperature
- Lecture 20 - Tube surrounded by isothermal flow
- Lecture 21 - Heat transfer to fully developed flow - I
- Lecture 22 - Heat transfer to fully developed flow - II
- Lecture 23 - Laminar slug flow
- Lecture 24 - Power law fluids
- Lecture 25 - Forced convection - Tutorial I
- Lecture 26 - Forced convection - Tutorial II
- Lecture 27 - Forced convection - Tutorial III
- Lecture 28 - Introduction to external natural convection
- Lecture 29 - Scaling analysis - I
- Lecture 30 - Scaling analysis - II
- Lecture 31 - Integral solution



- Lecture 32 - Similarity solution
- Lecture 33 - Uniform wall heat flux
- Lecture 34 - Thermal stratification
- Lecture 35 - Mixed convection
- Lecture 36 - Internal natural convection - Scaling analysis
- Lecture 37 - Heat transfer regimes
- Lecture 38 - Regime III
- Lecture 39 - Regime IV - Shallow enclosure limit - I
- Lecture 40 - Regime IV - Shallow enclosure limit - II
- Lecture 41 - Partially divided enclosures
- Lecture 42 - Inclined enclosures
- Lecture 43 - Natural convection - Tutorial I
- Lecture 44 - Natural convection - Tutorial II
- Lecture 45 - Introduction to Turbulence
- Lecture 46 - Reynolds-Averaged Navier Stokes equation - I
- Lecture 47 - Reynolds-Averaged Navier Stokes equation - II
- Lecture 48 - Turbulent boundary layer - Viscous sub layer
- Lecture 49 - Turbulent boundary layer - Fully turbulent sub layer
- Lecture 50 - Heat transfer in turbulent boundary layer
- Lecture 51 - Turbulent internal flow - I
- Lecture 52 - Turbulent internal flow - II
- Lecture 53 - Turbulent internal flow - III
- Lecture 54 -  $k - \epsilon$  model
- Lecture 55 - Turbulence - Tutorial
- Lecture 56 - Experimental techniques - Thermochromic liquid crystals
- Lecture 57 - Experimental techniques - IR thermography
- Lecture 58 - Droplet evaporation - Sessile I
- Lecture 59 - Droplet evaporation - Sessile II
- Lecture 60 - Droplet evaporation - Contact free

Lecture 1 - Introduction to complex variables

Lecture 2 - Cauchy Riemann Equations

Lecture 3 - Analytic Functions

Lecture 4 - Simple definitions

Lecture 5 - Definition of sets, domains, theorem on antiderivative

Lecture 6 - Cauchy Goursat Theorem

Lecture 7 - Implications of Cauchy Goursat Theorem, Cauchy Integral Formula

Lecture 8 - Implications of CIF, converse of CG theorem

Lecture 9 - Examples in contour integrals, ratios of polynomials

Lecture 10 - Contour integration of sinc function

Lecture 11 - Method of path deformation

Lecture 12 - Method of path deformation (Continued...)

Lecture 13 - Infinite and finite branch cuts

Lecture 14 - Finite Branch Cut

Lecture 15 - Infinite branch cut example

Lecture 16 - Contour integration: rectangular contour

Lecture 17 - Finite square root branch cut

Lecture 18 - Example on finite branch cut

Lecture 19 - Pole on a branch cut

Lecture 20 - L shaped branch cut

Lecture 21 - L shaped branch cut continued

Lecture 22 - Inverse Laplace Transform

Lecture 23 - Inverse Laplace Transform (Continued...)

Lecture 24 - Additional material or corrections to lectures

Lecture 25 - Summary of the total course

Lecture 1 - Introduction

Lecture 2 - Deborah number

Lecture 3 - Response of Elastic solid

Lecture 4 - Response of Viscous fluid

Lecture 5 - Viscoelastic material

Lecture 6 - Creep and stress relaxation

Lecture 7 - Creep and stress relaxation functions

Lecture 8 - Linearity

Lecture 9 - Mechanical Analogues

Lecture 10 - Tutorial

Lecture 11 - Atoms and bonds

Lecture 12 - Interatomic bonds

Lecture 13 - Polymers

Lecture 14 - Polymers (Continued...)

Lecture 15 - Polymers (Continued...)

Lecture 16 - Freely jointed model

Lecture 17 - Constitutive equations

Lecture 18 - Constitutive equations (Continued...)

Lecture 19 - Constitutive equations (Continued...)

Lecture 20 - Viscoelastic effects

Lecture 21 - Lab Session

Lecture 22 - Polymer concentrations

Lecture 23 - Lagrangian and Eulerian perspectives

Lecture 24 - Maxwell model

Lecture 25 - Maxwell model (Continued...)

Lecture 26 - Kelvin-Meyer-Voigt model

Lecture 27 - Three parameter model

Lecture 28 - Three parameter model (Continued...)

Lecture 29 - Three parameter model (Continued...)

Lecture 30 - Jefferey's model

Lecture 31 - Two Maxwell model

[Lecture 32 - N-Maxwell model](#)

[Lecture 33 - N-Maxwell model \(Continued...\)](#)

[Lecture 34 - N-Kelvin Meyer Voigt model](#)

[Lecture 35 - Constitutive modelling](#)

[Lecture 36 - Objectivity](#)

[Lecture 37 - Objectivity](#)

[Lecture 38 - Sinusoidal oscillations](#)

[Lecture 39 - Sinusoidal oscillations \(Continued...\)](#)

[Lecture 40 - Sinusoidal oscillations \(Continued...\)](#)

[Lecture 41 - Summary](#)

[Lecture 42 - Tutorial](#)

[Lecture 43 - Tutorial \(Continued...\)](#)

Lecture 1 - Introduction, Types and Classification of Robots

Lecture 2 - Main Elements of a Robot

Lecture 3 - Modelling and Analysis of Robots

Lecture 4 - Mathematical Preliminaries, Homogeneous Transformations

Lecture 5 - Elements of robot - Joints, Elements of robots - Links

Lecture 6 - Examples of D-H parameters and Link transformation matrices

Lecture 7 - Introduction, Direct Kinematics of Serial Robots

Lecture 8 - Inverse Kinematics of Serial Robots

Lecture 9 - Inverse Kinematics of Serial Robots with  $n < 6$ , Inverse Kinematics of Serial Robots with  $n > 6$

Lecture 10 - Elimination Theory and Solution of Non-linear Equations, Inverse Kinematics of a General 6R Robot

Lecture 11 - Introduction, Loop-closure Equations

Lecture 12 - Direct Kinematics of Parallel Manipulators

Lecture 13 - Mobility of Parallel Manipulators

Lecture 14 - Inverse Kinematics of Parallel Manipulators

Lecture 15 - Direct Kinematics of Stewart Platform Manipulators

Lecture 16 - Sun tracking using 3-DOF parallel manipulator

Lecture 17 - Stewart-Gough platform-based force-torque sensor

Lecture 18 - Vibration isolation using a Stewart-Gough platform

Lecture 19 - Introduction, Linear and Angular Velocity of Links

Lecture 20 - Serial Manipulator Jacobian Matrix

Lecture 21 - Parallel Manipulator Jacobian Matrix

Lecture 22 - Singularities in Serial and Parallel Manipulators

Lecture 23 - Statics of Serial and Parallel Manipulators

Lecture 24 - Hyper-redundant robots

Lecture 25 - Redundancy resolution in human arm

Lecture 26 - Flexible robots

Lecture 27 - Introduction, Lagrangian formulation

Lecture 28 - Examples of Equations of Motion

Lecture 29 - Inverse Dynamics and Simulation of Equations of Motion

Lecture 30 - Recursive Formulations of Dynamics of Manipulators

Lecture 31 - Motion planning

[Lecture 32 - Control of a single link](#)

[Lecture 33 - Control of a multi-link serial manipulator](#)

[Lecture 34 - Control of a multi-link manipulator](#)

[Lecture 35 - Control of constrained and parallel manipulator, Cartesian control of serial manipulators](#)

[Lecture 36 - Force control of manipulators, Hybrid position/force control of manipulators](#)

[Lecture 37 - Advanced topics in non-linear control of manipulators](#)

[Lecture 38 - Wheeled Mobile Robots \(WMR\) on Flat Terrain](#)

[Lecture 39 - Wheeled Mobile Robots \(WMR\) on Uneven Terrain](#)

[Lecture 40 - Kinematics and Dynamics of WMR on Uneven Terrain](#)

[Lecture 41 - Over-Constrained Mechanism and Deployable Structures](#)

[Lecture 42 - Kinematic and Static Analysis](#)

Lecture 1 - The longitudinal wave in vibrating spring

Lecture 2 - Harmonically excited systems

Lecture 3 - The concept of coincidence frequency

Lecture 4 - A classical problem in sound-structure interaction

Lecture 5 - Classical problem (Continued...)

Lecture 6 - Uncoupled solution to the classical problem

Lecture 7 - Uncoupled solution (Continued...).

Lecture 8 - Introduction to the coupled problem.

Lecture 9 - The coupled roots

Lecture 10 - Physical meaning of terms

Lecture 11 - Derivation of coupled roots using asymptotic method

Lecture 12 - Coupled roots derivation (Continued...)

Lecture 13 - Regions of heavy and light fluid loading

Lecture 14 - Light and heavy fluid loading (Continued...)

Lecture 15 - The coupled vibration field

Lecture 16 - The coupled acoustic field and stationary phase

Lecture 17 - The 2-D structural-acoustic waveguide

Lecture 18 - The coupled partial differential equations

Lecture 19 - Derivation of the coupled dispersion equation

Lecture 20 - A schematic of coupled waves

Lecture 21 - Derivation of coupled waves using asymptotic method

Lecture 22 - Asymptotic method (Continued...) and Maple demo

Lecture 23 - Physics of the coupled waves

Lecture 24 - Critical points

Lecture 25 - Heavy fluid loading

Lecture 26 - Summary of the rectangular waveguide

Lecture 27 - Impedance and mobility

Lecture 28 - Derivation of acoustic and vibration response

Lecture 29 - Derivation of vibro-acoustic response (Continued...)

Lecture 30 - Derivation of vibro-acoustic response (Continued...)

Lecture 31 - Numerical example

- Lecture 32 - Coupled resonance analysis using matrices
- Lecture 33 - Coupled resonance analysis (Continued...)
- Lecture 34 - Sound radiation from a baffled panel
- Lecture 35 - Derivation of pressure response.
- Lecture 36 - Radiation efficiency
- Lecture 37 - Physics of volume velocity cancellation
- Lecture 38 - Derivations in the frequency domain: 1-D
- Lecture 39 - Physics of the vibration spectrum in 2-D
- Lecture 40 - Modal character across the frequency range
- Lecture 41 - Simultaneous radiation from several modes
- Lecture 42 - Panel radiation model using monopoles
- Lecture 43 - Physics of panel radiation using monopole model
- Lecture 44 - Physics of panel radiation using monopole model (Cointinued...)
- Lecture 45 - Radiation resistance derivation from Maidanikâ€™s work (Continued...)
- Lecture 46 - Radiation resistance derivation from Maidanikâ€™s work (Continued...)
- Lecture 47 - Radiation resistance derivation from Maidanikâ€™s work (Continued...)
- Lecture 48 - Modal average radiation efficiency
- Lecture 49 - Modal average radiation efficiency (Cointinued...)
- Lecture 50 - Transmission of sound through a rigid panel with flexible mounts
- Lecture 51 - Frequency dependence of sound transmission
- Lecture 52 - Sound transmission through a flexible partition
- Lecture 53 - Transmission loss in different situations
- Lecture 54 - Cylindrical shell vibration
- Lecture 55 - Behavior of uncoupled shell waves
- Lecture 56 - Fluid waves in rigid-walled cylindrical shells
- Lecture 57 - Wave propagation characteristics in flexible cylindrical shells carrying fluid: Fullers paper
- Lecture 58 - Wave impedance of an infinite plate: fluid loading
- Lecture 59 - Fluid loading in a finite plate
- Lecture 60 - Summary of the entire course



- Lecture 1 - Introduction to differential geometry
- Lecture 2 - Properties of surfaces: First fundamental form
- Lecture 3 - Properties of surfaces: Second fundamental form
- Lecture 4 - Surfaces of revolution
- Lecture 5 - Gauss Codazzi relations
- Lecture 6 - Gauss Codazzi (Continued...)
- Lecture 7 - Differential element length in a thin shell
- Lecture 8 - Strain of a differential element
- Lecture 9 - Explicit strain expressions
- Lecture 10 - Love simplifications and inconsistencies Of the theory
- Lecture 11 - Euler Bernoulli Beam equation using the Hamilton's Law
- Lecture 12 - Euler Bernoulli Beam and Hamilton's Law (Continued...)
- Lecture 13 - Beta definition, force and moment resultants
- Lecture 14 - Hamilton's Law for a general shell
- Lecture 15 - The Hamilton's law (Continued...)
- Lecture 16 - Final Dynamical Equations and boundary conditions
- Lecture 17 - Physics of each term in the dynamic equations
- Lecture 18 - Physics of each term (Continued...)
- Lecture 19 - The sixth equation of motion
- Lecture 20 - The sixth equation of motion (Continued...)
- Lecture 21 - Equations of motion for a rectangular plate using Hamilton's law
- Lecture 22 - Equations of motion for a rectangular Plate (Continued...)
- Lecture 23 - Rectangular plate boundary conditions
- Lecture 24 - Rectangular plate equation using force balance
- Lecture 25 - Modeshapes and resonances of a vibrating beam
- Lecture 26 - Modeshapes and resonances of a vibrating Rectangular plate
- Lecture 27 - Modeshapes and resonances of a vibrating Circular plate
- Lecture 28 - Vibrating circular plate (Continued...)
- Lecture 29 - Modeshapes and resonances of a vibrating Circular ring
- Lecture 30 - Details of vibrating rings
- Lecture 31 - Insights into vibrations of ring

- Lecture 32 - Cylindrical shell equations of motion using Force balance
- Lecture 33 - Cylindrical shell: Transverse equation of motion
- Lecture 34 - Orthogonality of modeshapes
- Lecture 35 - Orthogonality of Modes (Continued...)
- Lecture 36 - The Rayleigh Quotient
- Lecture 37 - Rayleigh Quotient Example: Simply-supported beam
- Lecture 38 - The Rayleigh Ritz method
- Lecture 39 - The Rayleigh Ritz method applied to a Complicated system
- Lecture 40 - The Lagrange Multiplier method
- Lecture 41 - The penalty method
- Lecture 42 - Orthogonal polynomials of RB Bhat
- Lecture 43 - Rayleigh Ritz paper by RB Bhat
- Lecture 44 - Numerical examples of the Rayleigh Ritz method
- Lecture 45 - Numerical examples of Rayleigh Ritz method And animations
- Lecture 46 - Rayleigh Ritz applied to curved structures
- Lecture 47 - Forced response of plates and shells
- Lecture 48 - Forced response (Continued...)
- Lecture 49 - Simply-supported plate response to various forces
- Lecture 50 - Simply-supported plate response to various Forces (Continued...)
- Lecture 51 - Simply-supported cylindrical shell response to a Point harmonic force
- Lecture 52 - Cylindrical shell response (Continued...)
- Lecture 53 - Cylindrical shell response (Continued...)
- Lecture 54 - Cylindrical shell response to a traveling load using Only transverse modes
- Lecture 55 - The Receptance method
- Lecture 56 - The receptance method (Continued...)
- Lecture 57 - Stiffening a cylindrical shell using rings
- Lecture 58 - Stiffening of a cylindrical shell (Continued...)
- Lecture 59 - Damping in structures
- Lecture 60 - Loss factor and Complex Young modulus

Lecture 1 - Introduction to Course

Lecture 2 - Position and Orientation of a Rigid Body

Lecture 3 - Homogenous Transformation

Lecture 4 - Linear and angular velocity of rigid body

Lecture 5 - Motion of Rigid Body and Particles

Lecture 6 - Introduction to multi-body systems

Lecture 7 - Joints, Degrees of Freedom and Constraints

Lecture 8 - Position, Velocity and Acceleration in Multi-body Systems

Lecture 9 - Mass and Inertia of a Rigid Body

Lecture 10 - External forces and moments

Lecture 11 - Angular momentum, Spinning tops and Gyroscopes

Lecture 12 - Free-body diagram and Equations of motion

Lecture 13 - Newton-Euler Formulation for Serial Chains

Lecture 14 - Lagrangian Formulation

Lecture 15 - Examples of Equations of Motion

Lecture 16 - Equations of Motion Using Computer Tools

Lecture 17 - Introduction and Examples of equations of motion

Lecture 18 - Inverse dynamics and Simulations of equations Of motion

Lecture 19 - Simulation using Computer Tools

Lecture 20 - Introduction and Goal of control

Lecture 21 - State Space Formulation

Lecture 22 - Solution of State Equations

Lecture 23 - Stability of Dynamical Systems

Lecture 24 - Controllability and Observability of Linear Systems

Lecture 25 - Examples of Controllability and Observability

Lecture 26 - Introduction to Classical Control

Lecture 27 - Root Locus

Lecture 28 - Frequency Domain Approach

Lecture 29 - PID Control

Lecture 30 - Root Locus based Controller Design

Lecture 31 - State Space Design



Lecture 1 - Introduction

Lecture 2 - Mathematical Preliminaries - I

Lecture 3 - Tensors and Deformations

Lecture 4 - Lagrangian and Eulerian Perspectives

Lecture 5 - Mathematical Preliminaries - II

Lecture 6 - Image Processing Preliminaries

Lecture 7 - Image Processing Operations

Lecture 8 - Light Matter Interaction - I

Lecture 9 - Lab Demo I: Optical Microscope

Lecture 10 - Optical System: Lenses

Lecture 11 - Lab Demo II: Lenses and Camera

Lecture 12 - Light Matter Interaction - II (Lab Demonstration)

Lecture 13 - Light Matter Interaction - II (Lab Demonstration)

Lecture 14 - Tracer Particles for Flow Visualisation

Lecture 15 - Particle Tracking Velocimetry

Lecture 16 - Particle Image Velocimetry - I

Lecture 17 - Particle Image Velocimetry - II

Lecture 18 - Particle Image Velocimetry - III

Lecture 19 - Particle Image Velocimetry - IV

Lecture 20 - Particle Image Velocimetry - V

Lecture 21 - Particle Image Velocimetry - VI

Lecture 22 - Schlieren and Shadowgraphy

Lecture 23 - Lab Demo III: PIV and Schlieren

Lecture 24 - Introduction to optical methods for solids

Lecture 25 - Basics of Digital Image Correlation

Lecture 26 - Iterative implementation of DIC

Lecture 27 - Example implementations

Lecture 28 - How is a DIC experiment set up ?

Lecture 29 - DIY(C)!

Lecture 30 - Introduction to Photoelasticity

Lecture 31 - Why do we see fringes ?

[Lecture 32 - How does light interact with matter ?](#)

[Lecture 33 - Origin of Birefringence](#)

[Lecture 34 - Loaded sample in a polarizer](#)

[Lecture 35 - Stress-induced birefringence](#)

[Lecture 36 - Analyses of optical paths using matrix methods](#)

[Lecture 37 - Putting it all together](#)

[Lecture 38 - What is tomography ?](#)

[Lecture 39 - Signal processing and Fourier methods](#)

[Lecture 40 - Rays and the Radon transforms](#)

[Lecture 41 - Geometric interpretations](#)

[Lecture 42 - The inverse problem: From Radon transform to 2D cross-section](#)

[Lecture 43 - Cone beams, parallel beams and the Feldkamp algorithm](#)

Lecture 1 - Introduction to Statistical Thermodynamics

Lecture 2 - Basic Probability Theory and Statistics

Lecture 3 - Important Probability Distributions

Lecture 4 - Combinatorial Analysis for Statistical Thermodynamics

Lecture 5 - Basic Concepts

Lecture 6 - Macrostates and Microstates

Lecture 7 - Bose Einstein and Fermi Dirac Statistics

Lecture 8 - Entropy and the equilibrium particle distribution

Lecture 9 - Operator Theory - 1

Lecture 10 - Stirling Approximation and Lagrange Multipliers

Lecture 11 - Equilibrium particle distribution

Lecture 12 - The Dilute Limit and Concept of Molecular Partition Function

Lecture 13 - The Molecular Partition Function and its relationship with Classical Thermodynamics

Lecture 14 - Historical Survey of Quantum Mechanics

Lecture 15 - Operator Theory - 2

Lecture 16 - Operator Theory - 3

Lecture 17 - Bohr Model for the Spectrum of Atomic Hydrogen

Lecture 18 - Heuristic Introduction to the Schrodinger Equation

Lecture 19 - The postulates of Quantum Mechanics

Lecture 20 - The Steady State Schrodinger Equation: Single Particle Analysis

Lecture 21 - Coordinate System - 1

Lecture 22 - Coordinate System - 2

Lecture 23 - Coordinate System - 3

Lecture 24 - The Steady State Schrodinger Equation: Multiparticle analysis

Lecture 25 - The Particle in a Box

Lecture 26 - The Uncertainty Principle

Lecture 27 - The Pauli Exclusion and the Correspondence Principle

Lecture 28 - Problem Solving - 1

Lecture 29 - Problem Solving - 2

Lecture 30 - The Internal Motion for a two particle system

Lecture 31 - The rotational and vibrational energy mode for a diatomic molecule

- Lecture 32 - Hermite polynomials as vibrational energy mode solution
- Lecture 33 - Equivalent two body model of atomic hydrogen
- Lecture 34 - The Electronic Energy Mode for Atomic Hydrogen
- Lecture 35 - Problem Solving - 3
- Lecture 36 - The four quantum numbers and multielectron systems
- Lecture 37 - Spectroscopic term symbols for multielectron atoms
- Lecture 38 - Electron energies for multielectron systems
- Lecture 39 - Combined energy modes for atoms and diatomic molecules
- Lecture 40 - Perturbation analysis of the Schrodinger Wave equation
- Lecture 41 - Selection rules
- Lecture 42 - The Rotational and vibrational spectroscopy
- Lecture 43 - Ro-vibrational spectroscopy (Simplex model)
- Lecture 44 - Rotation vibration coupling (Complex model)
- Lecture 45 - Ro-vibrational spectroscopy (Complex model)
- Lecture 46 - Ro-vibronic spectroscopy
- Lecture 47 - Working with Spectroscopic Schemes, Notations and Term Symbols
- Lecture 48 - From Particles to assembly - I
- Lecture 49 - From Particles to assembly - II
- Lecture 50 - Connecting Quantum Mechanics to Classical Mechanics
- Lecture 51 - The Equipartition principle and ideal gas
- Lecture 52 - Thermodynamic properties of ideal monoatomic and diatomic gas
- Lecture 53 - The zero of energy (rotational and vibrational)
- Lecture 54 - Specific heats, Internal energy through Vibrational and Ro-vibrational energy modes
- Lecture 55 - The Ro-vibrational partition function and Introduction to intersction of Radiationand Matter
- Lecture 56 - Absorption and Emission of Radiation
- Lecture 57 - The Rabi frequency and Beer's Law
- Lecture 58 - Insights into radiative spectral transitions
- Lecture 59 - Theory of Absorption Spectroscopy



- Lecture 1 - The vibrating spring-mass-damper system
- Lecture 2 - Power calculations in a vibrating spring-mass-damper system
- Lecture 3 - Wave propagation on a string
- Lecture 4 - Examples of waves on strings: finite and semi-infinite cases
- Lecture 5 - General solution to 1-D wave equation: physical insights
- Lecture 6 - Wave solution: real notation vs complex notation
- Lecture 7 - The vibrating string with a general mechanical impedance
- Lecture 8 - The forced finite string with an end mass
- Lecture 9 - The one-D wave solution: physical insights
- Lecture 10 - Longitudinal wave propagation in a rod
- Lecture 11 - Forced semi-infinite and finite rods
- Lecture 12 - The derivation of the acoustic wave equation
- Lecture 13 - The derivation of the acoustic wave equation (Continued...)
- Lecture 14 - The derivation of the acoustic wave equation (Continued...)
- Lecture 15 - The derivation of the acoustic wave equation (Continued...)
- Lecture 16 - Sound propagation in piston driven semi-infinite and finite ducts
- Lecture 17 - Acoustics inside a piston driven finite duct with a general end impedance
- Lecture 18 - Time averaged power in a 1-D acoustic wave
- Lecture 19 - The Free Space Green Function in acoustics
- Lecture 20 - The Free Space Green Function (Continued...)
- Lecture 21 - Various Green Functions and their uses
- Lecture 22 - Derivation of the interior Kirchhoff Helmholtz Integral Equation
- Lecture 23 - Derivation of the exterior Kirchhoff Helmholtz Integral Equation
- Lecture 24 - Acoustic wave equation in spherical coordinates
- Lecture 25 - Legendre polynomials, spherical harmonics, orthogonality relations
- Lecture 26 - Spherical harmonics, Legendre polynomials and their orthogonality relations (Continued...)
- Lecture 27 - Interior Neumann Green function
- Lecture 28 - Exterior Neumann and Dirichlet Green functions
- Lecture 29 - Pulsating sphere using the exterior Neumann Green function
- Lecture 30 - Equivalence of Neumann Green function and separation of variables solution
- Lecture 31 - Sound from a pulsating sphere using boundary matching technique

- Lecture 32 - Sound from a pulsating sphere using boundary matching technique (Continued...)
- Lecture 33 - Sound radiation from a spherical cap on a rigid sphere using the Neumann Green function
- Lecture 34 - Scattering of a plane acoustic wave from a rigid sphere
- Lecture 35 - Example to show that the surface in the KHIE is notional (not actual)
- Lecture 36 - The Rayleigh Integral
- Lecture 37 - Sound field of an oscillating piston in a rigid baffle
- Lecture 38 - Sound field of an oscillating piston in a rigid baffle (Continued...)
- Lecture 39 - Physics of the sound field of an oscillating piston in a rigid baffle
- Lecture 40 - Physics of the sound field of an oscillating piston in a rigid baffle (Continued...)
- Lecture 41 - Physics of the sound field of the oscillating piston (cap) on a rigid sphere
- Lecture 42 - The Sommerfeld radiation condition
- Lecture 43 - Sound field inside a rigid walled box due to initial conditions
- Lecture 44 - Sound field inside a rigid walled box due to a harmonic source
- Lecture 45 - Sound field inside a rigid walled hollow cylinder due to initial conditions
- Lecture 46 - Modeshape visualization inside a rigid walled cylinder
- Lecture 47 - Sound field inside a rigid walled hollow cylinder due to initial conditions (Continued...)
- Lecture 48 - Green function inside a rigid walled cylinder
- Lecture 49 - Measures of sound
- Lecture 50 - Measures of sound (Continued...)
- Lecture 51 - Average mean square value of different frequency sinusoids
- Lecture 52 - Frequency analysis of sounds in terms of third octave bands
- Lecture 53 - Transient solution of the wave equation using Fourier series
- Lecture 54 - Total soln of harmonically forced wave equation with initial conditions using Fourier series
- Lecture 55 - Total soln of forced wave eqn with initial conditns using Laplace transform and Fourier series
- Lecture 56 - Branched systems, Helmholtz resonator
- Lecture 57 - The radiation impedance and acoustic power
- Lecture 58 - Acoustic potential, combined systems, special techniques for solving acoustic wave equation
- Lecture 59 - Why do we take the real value of the solution in acoustic wave problems
- Lecture 60 - Course summary - Part 1
- Lecture 61 - Course summary - Part 2