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**Co-ordinators : Dr. P. Banerji**

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**Co-ordinators : Dr. T.I. Eldho**

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**NPTEL : Structural Analysis II (Civil Engineering)**

**Co-ordinators : Dr. P. Banerji**

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**NPTEL : Geotechnical Earthquake Engineering (Civil Engineering)**

**Co-ordinators : Dr. Deepankar Choudhury**

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[Lecture 44 - Deviatoric stress and strain, deformation gradient and Jacobian matrix](#)

[Lecture 45 - General definition of 3D strain, application of Jacobian matrix](#)

[Lecture 46 - Application of Jacobian matrix, nonhomogeneous deformation](#)

[Lecture 47 - Rotation and translation - changes in coordinates](#)

[Lecture 48 - Principles of 1g analogue modeling - I](#)

[Lecture 49 - Principles of 1g analogue modeling - II](#)

[Lecture 50 - Principles of 1g analogue modeling - III](#)

[Lecture 51 - Anderson's theory of faulting](#)

[Lecture 52 - Stereoplot of principal stress axes - I](#)

[Lecture 53 - Stereoplot of principal stress axes - II](#)

[Lecture 54 - Stereoplot of principal stress axes - III](#)

[Lecture 55 - Deduction of principal stress axes orientation from fault data](#)

[Lecture 56 - Elementary stress problems dealing with stereonet - I](#)

[Lecture 57 - Elementary stress problems dealing with stereonet - II](#)

[Lecture 58 - Poroelasticity - I](#)

[Lecture 59 - Poroelasticity - II, stereonet problem](#)

[Lecture 60 - Poroelasticity - III](#)

**NPTEL : Concrete Technology (Civil Engineering)**

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

Lecture 1 - Production and Composition

Lecture 2 - Structure and Hydration

Lecture 3 - Structure and Hydration

Lecture 4 - Properties and Tests

Lecture 5 - Types and Use

Lecture 6 - Aggregates (Size, Shape)

Lecture 7 - Packing, FM, SM

Lecture 8 - Properties

Lecture 9 - Chemical Admixtures

Lecture 10 - Chemical Admixtures

Lecture 11 - Mineral Admixtures

Lecture 12 - Mineral Admixtures

Lecture 13 - Mineral Admixtures

Lecture 14 - Mix Proportioning of Concrete: General Principles

Lecture 15 - Mix design of Concrete: General and IS Method

Lecture 16 - Mix Design of Concrete: Is Example and British (DOE) Method

Lecture 17 - Mix Design of concrete: ACI 211 Method

Lecture 18 - Mix Design of concrete: Packing Density, Rheology

Lecture 19 - Batching and Mixing of concrete: General Principles

Lecture 20 - RMC and Transporting Concrete

Lecture 21 - Workability and Pumping of Concrete

Lecture 22 - Compaction and Curing Concrete

Lecture 23 - Strength of Concrete: Factors Affecting

Lecture 24 - Strength of Concrete: Aggregate Contribution

Lecture 25 - Strength of Concrete: Factors Affecting Test Results

Lecture 26 - Mechanical Properties of Concrete: Elastic Modulus, Poisson's Ratio, Fatigue, Impact

Lecture 27 - Creep of Concrete

Lecture 28 - Creep and Shrinkage of Concrete

Lecture 29 - Shrinkage of Concrete

Lecture 30 - Shrinkage of Concrete

Lecture 31 - Fundamental Concepts, Degradation Process, Attacks

[Lecture 32 - Frost Action and Rebar Corrosion](#)

[Lecture 33 - Carbonation and Chloride Affect](#)

[Lecture 34 - Rebar Corrosion](#)

[Lecture 35 - Rebar Corrosion and General Strategy](#)

[Lecture 36 - High Strength Concrete](#)

[Lecture 37 - High Strength Matrics and SCC](#)

[Lecture 38 - Self Compacting Concrete](#)

[Lecture 39 - Fiber Concrete](#)

[Lecture 40 - Fiber and Roller Compacted Concrete](#)

[Lecture 41 - Special Concrete and Sustainability](#)

**NPTEL : Seismic Analysis of Structures (Civil Engineering)**

**Co-ordinators : Dr. T.K. Datta, Dr. Ashok Gupta**

- [Lecture 1 - Seismology](#)
- [Lecture 2 - Seismology \(Continued...\)](#)
- [Lecture 3 - Seismology \(Continued...\)](#)
- [Lecture 4 - Seismology \(Continued...\)](#)
- [Lecture 5 - Seismic Inputs](#)
- [Lecture 6 - Seismic Inputs \(Continued...\)](#)
- [Lecture 7 - Seismic Inputs \(Continued...\)](#)
- [Lecture 8 - Seismic Inputs \(Continued...\)](#)
- [Lecture 9 - Response Analysis for Specified Ground Motion](#)
- [Lecture 10 - Response Analysis for Specified Ground Motion \(Continued...\)](#)
- [Lecture 11 - Response Analysis for Specified Ground Motion \(Continued...\)](#)
- [Lecture 12 - Response Analysis for Specified Ground Motion \(Continued...\)](#)
- [Lecture 13 - Response Analysis for Specified Ground Motion \(Continued...\)](#)
- [Lecture 14 - Response Analysis for Specified Ground Motion \(Continued...\)](#)
- [Lecture 15 - Frequency Domain Spectral Analysis](#)
- [Lecture 16 - Frequency Domain Spectral Analysis.](#)
- [Lecture 17 - Frequency Domain Spectral Analysis \(Continued...\)](#)
- [Lecture 18 - Frequency Domain Spectral Analysis \(Continued...\)](#)
- [Lecture 19 - Frequency Domain Spectral Analysis \(Continued...\)](#)
- [Lecture 20 - Response Spectrum Method of Analysis](#)
- [Lecture 21 - Response Spectrum Method of Analysis.](#)
- [Lecture 22 - Response Spectrum Method of Analysis \(Continued...\)](#)
- [Lecture 23 - Response Spectrum Method of Analysis \(Continued...\)](#)
- [Lecture 24 - Response Spectrum Method of Analysis \(Continued...\)](#)
- [Lecture 25 - Inelastic Seismic Response of Structures](#)
- [Lecture 26 - Inelastic Seismic Response of Structures \(Continued...\)](#)
- [Lecture 27 - Inelastic Seismic Response of Structures \(Continued...\)](#)
- [Lecture 28 - Inelastic Seismic Response of Structures \(Continued...\)](#)
- [Lecture 29 - Inelastic Seismic Response of Structures \(Continued...\)](#)
- [Lecture 30 - Inelastic Seismic Response of Structures \(Continued...\)](#)

Lecture 1 - Functions Of Buildings

Lecture 2 - Role Of Material In Construction

Lecture 3 - Concrete:Material

Lecture 4 - Concrete Production (Continued...)

Lecture 5 - Concrete Production (Continued...)

Lecture 6 - Concrete:Production Pumping, Placing

Lecture 7 - Concrete:Production Curing

Lecture 8 - Cement: Hydration

Lecture 9 - Cement and Cementitious Material

Lecture 10 - Fresh Concrete

Lecture 11 - Fresh Concrete : Role of Mix Parameters

Lecture 12 - Fresh Concrete : Role of Admixtures

Lecture 13 - Fresh Concrete : Segregation Bleeding

Lecture 14 - Strength of Concrete - I

Lecture 15 - Strength of Concrete - II

Lecture 16 - Strength of Concrete - III

Lecture 17 - Mechanical Properties of Concrete - I

Lecture 18 - Mechanical Properties of Concrete - II

Lecture 19 - Strength of Concrete : Non Destructive

Lecture 20 - Durability of Concrete - I

Lecture 21 - Durability of Concrete - II

Lecture 22 - Durability of Concrete - III

Lecture 23 - Cement Aggregate and Water Selection

Lecture 24 - Mix Design of Concrete

Lecture 25 - Mix Design Of concrete IS Method

Lecture 26 - Mix Design Of Concrete: British

Lecture 27 - Masonry : Materials

Lecture 28 - Masonry : Walls

Lecture 29 - Masonry : Walls; Resistance - I

Lecture 30 - Masonry : Walls; Resistance - II

Lecture 31 - Walls : Functional Performances

[Lecture 32 - Walls : Defects and Durability](#)

[Lecture 33 - Metals Fundamentals](#)

[Lecture 34 - Metals and Iron Systems](#)

[Lecture 35 - Steel : Uses in Construction](#)

[Lecture 36 - Steel : Uses in Rebar](#)

[Lecture 37 - Polymer in Construction](#)

[Lecture 38 - Polymer in Construction : Uses](#)

[Lecture 39 - Glass and Timber : Glass](#)

[Lecture 40 - Glass and Timber : Timber](#)

[Lecture 41 - Roof and Floor Construction](#)

**NPTEL : Water Management (Civil Engineering)**

**Co-ordinators : Dr. A.K. Gosain**

- Lecture 1 - Introduction to Irrigation Water Management
- Lecture 2 - Soil - Water - Plant Relationships
- Lecture 3 - Soil - Water - Plant Relationships (Continued...)
- Lecture 4 - Soil - Water - Plant Relationships (Continued...)
- Lecture 5 - Soil - Water - Plant Relationships (Continued...)
- Lecture 6 - Soil - Water - Plant Relationships (Continued...) and Infiltration
- Lecture 7 - Crop Water Requirements
- Lecture 8 - Crop Water Requirements (Continued...)
- Lecture 9 - Crop Water Requirements (Continued...)
- Lecture 10 - Crop Water Requirements (Continued...)
- Lecture 11 - Crop Water Requirements (Continued...)
- Lecture 12 - Crop Water Requirements (Continued...)
- Lecture 13 - Crop Water Requirements (continued...)
- Lecture 14 - Irrigation Efficiencies - Part I
- Lecture 15 - Irrigation Efficiencies - Part II and Irrigation Methods and their Suitability
- Lecture 16 - Irrigation Methods - III
- Lecture 17 - Irrigation Methods - IV
- Lecture 18 - Irrigation Methods - V
- Lecture 19 - Irrigation Methods - VI
- Lecture 20 - Irrigation Methods and their Suitability
- Lecture 21 - Border Irrigation System - I
- Lecture 22 - Border Irrigation System - II
- Lecture 23 - Border Irrigation System - III
- Lecture 24 - Border Irrigation System - IV
- Lecture 25 - Furrow Irrigation System - I
- Lecture 26 - Furrow Irrigation System - II
- Lecture 27 - Furrow Irrigation System - III
- Lecture 28 - Furrow Irrigation System - IV
- Lecture 29 - Sprinkler Irrigation System - I
- Lecture 30 - Sprinkler Irrigation System - II
- Lecture 31 - Sprinkler Irrigation System - III

[Lecture 32 - Sprinkler Irrigation System - IV](#)

[Lecture 33 - Sprinkler Irrigation System - V](#)

[Lecture 34 - Sprinkler Irrigation System - VI](#)

[Lecture 35 - Sprinkler Irrigation System - VII](#)

[Lecture 36 - Sprinkler Irrigation System - VIII](#)

[Lecture 37 - Drip Irrigation System - I](#)

[Lecture 38 - Drip Irrigation System - II](#)

[Lecture 39 - Drip Irrigation System - III](#)

[Lecture 40 - Drip Irrigation System - IV](#)



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

## **NPTEL : NOC:Geoenvironmental Engineering (Environmental Geotechnology) Landfills, Slurry Ponds and Contaminated Sites (Civil Engineering)**

**Co-ordinators : Prof. Manoj Datta**

Lecture 1 - Introduction to Geoenvironmental Engineering

Lecture 2 - Sources and Impact of Contamination

Lecture 3 - Waste-Soil Interaction

Lecture 4 - Solid Waste Generation and Disposal

Lecture 5 - Waste Minimization by Integrated Solid Waste Management (ISWM)

Lecture 6 - Integrated Solid Waste Management (ISWM) - Case Studies

Lecture 7 - Principles of Landfilling

Lecture 8 - Planning of Landfills - Part 1

Lecture 9 - Planning of Landfills - Part 2

Lecture 10 - Liners for Landfills - Part 1

Lecture 11 - Liners for Landfills - Part 2

Lecture 12 - Liners for Landfills - Part 3

Lecture 13 - Liners for Landfills - Part 4

Lecture 14 - Covers for Landfills - Part 1

Lecture 15 - Covers for Landfills - Part 2

Lecture 16 - Generation and Control of Leachate

Lecture 17 - Generation and Control of Landfill Gas

Lecture 18 - Stability of Slopes - Part 1

Lecture 19 - Stability of Slopes - Part 2

Lecture 20 - Stability of Slopes - Part 3

Lecture 21 - (Lecture Missing)

Lecture 22 - Some Solved Examples

Lecture 23 - Subsurface Monitoring Around Landfills - Part 1

Lecture 24 - Subsurface Monitoring Around Landfills - Part 2

Lecture 25 - Cost of Geotechnical Components of Landfills

Lecture 26 - Construction and Operation of Landfills

Lecture 27 - Site Selection for Landfills

Lecture 28 - Closure, Rehabilitation and Expansion of MSW Landfills

Lecture 29 - Control and Remedial Measures at Contaminated Sites - Part 1

Lecture 30 - Control and Remedial Measures at Contaminated Sites - Part 2

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[Lecture 31 - Slurry Disposal on Land](#)

[Lecture 32 - Disposal of Slurry Waste in Ponds and Impoundments and Dry Waste in Mounds](#)

[Lecture 33 - Geotechnical Properties of Coal Ash and Mine Tailings - Part 1](#)

[Lecture 34 - Geotechnical Properties of Coal Ash and Mine Tailings - Part 2](#)

[Lecture 35 - Planning and Design of Slurry Ponds](#)

[Lecture 36 - Stability of Incrementally Raised Embankments - Part 1](#)

[Lecture 37 - Stability of Incrementally Raised Embankments - Part 2](#)

[Lecture 38 - Remedial Measures for Slope Failures in Embankments / Dykes of Slurry Ponds](#)

[Lecture 39 - Environmental Control at Slurry Ponds](#)

[Lecture 40 - Geotechnical Reuse of Waste Materials - Part 1](#)

[Lecture 41 - Geotechnical Reuse of Waste Materials - Part 2](#)

[Lecture 42 - End-of-the-Course Review](#)

- Lecture 1 - Introduction to Environmental Factors - 1
- Lecture 2 - Introduction to Environmental Factors - 2
- Lecture 3 - Introduction to Environmental Factors - 3
- Lecture 4 - Introduction to Environmental Factors - 4
- Lecture 5 - Introduction to Environmental Factors - 5
- Lecture 6 - Introduction to Environmental Factors - 6
- Lecture 7 - Introduction to Environmental Factors - 7
- Lecture 8 - Comfort and Heat Transfer Concepts
- Lecture 9 - Heat Flow in Buildings - 1
- Lecture 10 - Heat Flow in buildings - 2
- Lecture 11 - Heat Flow in buildings - 3
- Lecture 12 - Admittance Method - 1
- Lecture 13 - Admittance Method - 2
- Lecture 14 - Heat Flow in buildings - 1 (Frequency Domain)
- Lecture 15 - Heat Flow in buildings - 2 (Frequency Domain)
- Lecture 16 - Heat Flow in buildings - 2 (Frequency Domain)
- Lecture 17 - Heat flow in buildings
- Lecture 18 - Admittance Method
- Lecture 19 - Comfort - 1
- Lecture 20 - Comfort - 2
- Lecture 21 - Comfort and Thermal Design of Buildings - 1
- Lecture 22 - Comfort and Thermal Design of Buildings - 2
- Lecture 23 - Comfort and Thermal Design of Buildings - 3
- Lecture 24 - Thermal Design of Unconditioned Building
- Lecture 25 - External Shading Multipliers for external suns shading
- Lecture 26 - Passive Concepts
- Lecture 27 - Design for Thermal Efficiency
- Lecture 28 - Ventilation - 1
- Lecture 29 - Ventilation - 2
- Lecture 30 - Natural ventilation design
- Lecture 31 - Noise and Acoustic Fundamentals - 1

- Lecture 32 - Noise and Acoustic Fundamentals - 2
- Lecture 33 - Noise and Acoustic Fundamentals - 3
- Lecture 34 - Noise and Acoustic Fundamentals, Noise Outdoors
- Lecture 35 - Noise outdoors
- Lecture 36 - Sound within enclosure - 1
- Lecture 37 - Sound within enclosure - 2
- Lecture 38 - Sound within enclosure - 3
- Lecture 39 - Sound within enclosure - 4
- Lecture 40 - Sound within enclosure - 5
- Lecture 41 - Sound within enclosure - 6
- Lecture 42 - Sound within enclosure, isolation
- Lecture 43 - Isolation - 1
- Lecture 44 - Isolation - 2
- Lecture 45 - Auditorium - 1
- Lecture 46 - Auditorium - 2
- Lecture 47 - Daylighting - 1
- Lecture 48 - Daylighting - 2
- Lecture 49 - Daylighting - 3
- Lecture 50 - Daylighting - 4
- Lecture 51 - Daylighting - 5
- Lecture 52 - Daylighting - 6
- Lecture 53 - Artificial Lighting
- Lecture 54 - Design Sky models
- Lecture 55 - Live Session

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

**NPTEL : NOC:Fire Protection, Services and Maintenance Management of Building (Civil Engineering)**

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

Lecture 1 - Basic concepts of Fire Protection - I

Lecture 2 - Basic concepts of Fire Protection - II

Lecture 3 - Fire Resistance

Lecture 4 - Introduction Process of Combustion

Lecture 5 - ventilation and fuel Process of Combustion controlled fire

Lecture 6 - Process of Combustion: Flashover condition

Lecture 7 - Effect of Fire on Construction Materials

Lecture 8 - Design for Fire Resistance: Steel

Lecture 9 - Design for Fire Resistance: Steel

Lecture 10 - Design for Fire Resistance: Concrete

Lecture 11 - Fire Safety: Urban Planning

Lecture 12 - Fire Safety: Escape and Refuge

Lecture 13 - Fire safety: Internal planning, Detection and Suppression

Lecture 14 - Fire Safety: Detection and Suppression

Lecture 15 - Introduction to Lift Design

Lecture 16 - Design of Lift systems

Lecture 17 - Design of Lift systems: expected stops and floor of reversal

Lecture 18 - Design of Lift systems: Different cases

Lecture 19 - Design of Lift systems: Simulation and arrangement and Escalators

Lecture 20 - Introduction to System and Flow Systems

Lecture 21 - Water Supply System: Constant Demand

Lecture 22 - Water Supply System: Variable Demand and Diversity Factor

Lecture 23 - Diversity factor (Continued...)

Lecture 24 - Control Systems

Lecture 25 - Introduction to HVAC

Lecture 26 - Governing Equations for HVAC Process

Lecture 27 - Numerical Problem on HVAC System

Lecture 28 - Numerical Problem on HVAC System (Continued...)

Lecture 29 - Psychrometric Chart: Equation based Approach

Lecture 30 - Flow in Pipe Networks and Fixture Units

Lecture 31 - Flow in Pipe Networks (Continued...) and Design of Water Supply Distribution System

[Lecture 32 - Design of Water Supply Distribution System \(Continued...\) and Flow in Waste Water pipes](#)

[Lecture 33 - Electrical Systems \(introduction\)](#)

[Lecture 34 - Design of Electrical Systems](#)

[Lecture 35 - Intelligent Building](#)

[Lecture 36 - Life cycle cost and basics of building maintenance](#)

[Lecture 37 - Stages of maintenance management](#)

[Lecture 38 - Planning for building maintenance](#)

[Lecture 39 - Periodicity of maintenance management](#)

[Lecture 40 - Estimation of repair cycle](#)

[Lecture 41 - Cost profile of maintenance](#)

[Lecture 42 - Lamp replacement](#)

[Lecture 43 - Building inspection, Planned and Ad-hoc maintenance](#)

[Lecture 44 - Condition survey and health evaluation of buildings](#)

[Lecture 45 - Diagnosis of building by visual survey](#)

[Lecture 46 - Case studies of visual survey](#)

[Lecture 47 - Effect of corrosion and Alkali Aggregate Reaction](#)

[Lecture 48 - Sampling and choice of test location](#)

[Lecture 49 - Non Destructive Testing - 1](#)

[Lecture 50 - Non Destructive Testing - 2](#)

[Lecture 51 - Core strength test](#)

[Lecture 52 - Carbonation and Chloride measurement](#)

[Lecture 53 - Electrical methods of progress measurement](#)

[Lecture 54 - Repair, Rehabilitation and Retrofit](#)

[Lecture 55 - Periodicity and economics of condition survey](#)

[Lecture 56 - Interpretation of test results](#)

Lecture 1 - Introduction and Planet Equivalent

Lecture 2 - Basics of Carbon Cycle

Lecture 3 - Factors Affecting carbon Cycle

Lecture 4 - Fundamentals of Sustainability

Lecture 5 - Role of Materials and Embodied Energy

Lecture 6 - Case Study for Energy in Building

Lecture 7 - Calculation of Ecological Footprint

Lecture 8 - Role of Cement in Sustainability and Calculation of Chemical Exergy

Lecture 9 - Fuel for Cement

Lecture 10 - Cementitious/Supplementary Cementitious Materials and Their Characterization

Lecture 11 - Strength of Concrete With Supplementary Cementitious Materials and Composite Cements

Lecture 12 - Types of Composite Cements

Lecture 13 - Alternative Fuel for cement and Embodied Energy

Lecture 14 - Life Cycle Embodied Energy and Concrete Sustainability

Lecture 15 - Strength of Concrete and Use of Admixtures

Lecture 16 - Curing Methods and Use of Waste Water for Mixing and Curing

Lecture 17 - Modern Composite Concrete

Lecture 18 - Recycled Aggregate-ITZ and Processing

Lecture 19 - Classification of Recycled Aggregate: Crushing and Grinding of Aggregates

Lecture 20 - Crushing and Grinding: Bond's Law+Operational Energy: U-Value

Lecture 21 - Operational Energy: Thermal Conductivity Models

Lecture 22 - Operational Energy: Thermal Conductivity Models (Continued...)

Lecture 23 - Operational Energy: Estimation of Thermal Conductivity

Lecture 24 - Thermal Diffusivity and Clay Bricks

Lecture 25 - Types of Bricks Kilns and Carbon Balance

Lecture 26 - Carbon Balance, Comparison of Various Types of Brick Kilns and Sealants, Paints, Adhesive

Lecture 27 - Sealants, Health Hazards of Building Materials and Emission Models

Lecture 28 - Emission Models and Testing

Lecture 29 - Energy Efficient Design of Buildings

Lecture 30 - Design Optimization of Buildings

Lecture 31 - Building Design Optimization Using Genetic Algorithm

[Lecture 32 - Urban Heat Island: Radiation Concepts](#)

[Lecture 33 - Urban Heat Island: Urban Canopy Layer](#)

[Lecture 34 - Evapotranspiration: Theory and Models](#)

[Lecture 35 - Evapotranspiration: Case Study and Surface Water Balance](#)

[Lecture 36 - Energy Conservation Building Code \(ECBC2007\)](#)

[Lecture 37 - Energy Conservation Building Code \(ECBC2007\) \(Continued...\)](#)

[Lecture 38 - ECBC Compliant Methodology](#)

[Lecture 39 - OTTV Methodology](#)

[Lecture 40 - Solar Energy and Solar Cells](#)

[Lecture 41 - Solar Photo Volatic Cells](#)

[Lecture 42 - Solar Water Heating](#)

[Lecture 43 - Design Strategies and the Green Design Process](#)

[Lecture 44 - Green Building Rating Systems](#)

[Lecture 45 - Autoclaved Aerated Concrete, Insulated Precast System and Insulated Precast Forms](#)

[Lecture 46 - Insulated Concrete Form and Tunnel Form](#)

[Lecture 47 - Modular Construction](#)



Lecture 1 - Introduction to Projects

Lecture 2 - Inputs to Scheduling

Lecture 3 - Critical Path Method

Lecture 4 - Precedence Diagramming Method

Lecture 5 - Line of Balance Method

Lecture 6 - Resource-driven Scheduling

Lecture 7 - Information-driven Scheduling

Lecture 8 - Dependency Structure Matrix - I

Lecture 9 - Dependency Structure Matrix - II

Lecture 10 - Dependency Structure Matrix - III

Lecture 11 - Beeline Diagramming Method

Lecture 12 - Other Scheduling Techniques

Lecture 1 - Introduction to Safety in Construction

Lecture 2 - Introduction to Safety Standards; Signs, Signals in Construction

Lecture 3 - Role of Stakeholders in Construction safety

Lecture 4 - Cost of Injury Vs Investment in Safety

Lecture 5 - Safety Program Accident/Incident Investigation

Lecture 6 - PPE in Construction

Lecture 7 - A Case Study on Construction Safety

Lecture 8 - Introduction to Fatal Falls

Lecture 9 - Fall hazard in Concerting

Lecture 10 - Fall hazard in Demolition Works

Lecture 11 - Safety in Demolition Work Practical Examples

Lecture 12 - Trench Cav-ins

Lecture 13 - Tunneling Safety

Lecture 14 - Struck by and Caught-inbetween

Lecture 15 - Crane Safety

Lecture 16 - A case Study on Construction Safety - Jigar-Crane

Lecture 17 - A case Study on Construction Safety - Safety Talk

Lecture 18 - Fire Safety and Steel Construction

Lecture 19 - Electrical Safety

Lecture 20 - A case Study on Construction Safety - Contractual Provision on Construction Zone Safety

Lecture 21 - Health Issues in Construction

Lecture 22 - Ergonomics and Health Issues with Concerting

Lecture 23 - General Safety Precautions

Lecture 24 - Safety in MEP Services

Lecture 25 - Managing Hazards in Construction

Lecture 26 - BIM for Construction

Lecture 27 - BIM for Safety

- Lecture 1 - Introduction - advanced hydraulics & course structure
- Lecture 2 - Various classifications of open channel flows
- Lecture 3 - Flow classifications & velocity distribution
- Lecture 4 - Pressure distribution
- Lecture 5 - Equation of continuity & energy
- Lecture 6 - Specific energy & critical flow
- Lecture 7 - Energy, momentum & specific force
- Lecture 8 - Computation of critical flow - Part 1
- Lecture 9 - Critical flow computations
- Lecture 10 - Introduction to uniform flow
- Lecture 11 - Manning's equation and normal depth
- Lecture 12 - Uniform Flow Computations - Part 1
- Lecture 13 - Uniform flow in compound sections, concept of normal slope
- Lecture 14 - Uniform flow approximation for flood discharge
- Lecture 15 - Design of channels for uniform flow
- Lecture 16 - Design of channels using uniform flow
- Lecture 17 - Design of erodible channels
- Lecture 18 - Introduction to gradually varied flows
- Lecture 19 - Gradually varied flow equations
- Lecture 20 - Classification of gradually varied flow - Part 1
- Lecture 21 - Classification of gradually varied flow - Part 2
- Lecture 22 - Gradually varied flow profiles with change in bed slopes
- Lecture 23 - GVF profile properties and transitional depths
- Lecture 24 - Gradually varied flow computations - Part 1
- Lecture 25 - Gradually varied flow computations RK method - Part 2
- Lecture 26 - Standard step method for gradually varied flow computations
- Lecture 27 - Spatially varied flow
- Lecture 28 - Features on spatially varied flow
- Lecture 29 - Rapidly varied flow - introduction
- Lecture 30 - Theoretical aspects of hydraulic jump
- Lecture 31 - Characteristics of jumps in rectangular channel

[Lecture 32 - Features of hydraulic jumps](#)

[Lecture 33 - Jumps as energy dissipators](#)

[Lecture 34 - Jump controls](#)

[Lecture 35 - Surges - Part 1](#)

[Lecture 36 - Surges - Part 2](#)

[Lecture 37 - Channel transitions - Part 1](#)

[Lecture 38 - Channel transitions - Part 2](#)

[Lecture 39 - Channel transitions - Part 3](#)

[Lecture 40 - Application of momentum principles](#)

[Lecture 41 - Pumps - 1](#)

[Lecture 42 - Turbines - Part 3 \(pumps, turbines\)](#)

[Lecture 43 - Turbines, cavitation](#)

**NPTEL : Design of Steel Structures (Civil Engineering)**

**Co-ordinators : Prof. Damodar Maity**

- Lecture 1 - Introduction to Design of Steel Structures
- Lecture 2 - Connections
- Lecture 3 - Riveted Connections
- Lecture 4 - Design of Rivet Joint
- Lecture 5 - Welding
- Lecture 6 - Design of Fillet and Butt Welds
- Lecture 7 - Bolted Connection
- Lecture 8 - Eccentric Connections: Rivet Joints
- Lecture 9 - Design of Eccentric Connection With Load Lying in Plane of Joint Rivet Bolt
- Lecture 10 - Eccentric Connection With Load Perpendicular to Plane of Riveted Joint
- Lecture 11 - Analysis and Design of Join with Seat Connection
- Lecture 12 - Eccentric Connection
- Lecture 13 - Load Lying Perpendicular to the Plane of Weld Joint
- Lecture 14 - Tension Member
- Lecture 15 - Design of Tension Member
- Lecture 16 - Design of Tension Member: Gusset Plates, Lug Angles and Tension Splices
- Lecture 17 - Design of Tension Member: Subjected to Axial and Bending
- Lecture 18 - Compression Member
- Lecture 19 - Design of Compression Member
- Lecture 20 - Design of Eccentrically Loaded tension Member
- Lecture 21 - Built up Compression Member
- Lecture 22 - Design of Built up Compression Member
- Lecture 23 - Lacing for Built Up Compression Member
- Lecture 24 - Design of Lacing System
- Lecture 25 - Design of Batten Plates
- Lecture 26 - Introduction to Flexural Members: Beams
- Lecture 27 - Design Procedure of Beam Members
- Lecture 28 - Design of Laterally Supported Beams
- Lecture 29 - Design of Laterally Unsupported Beams
- Lecture 30 - Built-Up Beams
- Lecture 31 - Built-Up Beams: Curtailment of the Flange Plates and Shear Connections

[Lecture 32 - Design of a Built-Up Beams](#)

[Lecture 33 - Design of Shear Connections and Purlins](#)

[Lecture 34 - Gantry Girders](#)

[Lecture 35 - Design of Gantry Girders](#)

[Lecture 36 - Introduction to Plate Girders - Part 1](#)

[Lecture 37 - Introduction to Plate Girders - Part 2](#)

[Lecture 38 - Design of a Plate Girder](#)

[Lecture 39 - Column Base - Part 1](#)

[Lecture 40 - Column Base - Part 2](#)

- Lecture 1 - Introduction to Hydraulics
- Lecture 2 - Open Channel Hydraulics - Part 1
- Lecture 3 - Open Channel Hydraulics - Part 2
- Lecture 4 - Velocity and Pressure Distribution
- Lecture 5 - Practical use of velocity co-efficient in channel flow
- Lecture 6 - Conservation Principles & Governing Equations
- Lecture 7 - Uniform Flow
- Lecture 8 - Uniform Flow Formula
- Lecture 9 - Computation of Uniform Flow - Part 1
- Lecture 10 - Computation of Uniform Flow - Part 2
- Lecture 11 - Uniform Flow in Mobile Boundary Channel
- Lecture 12 - Incipient Motion Condition and Regime of Flow
- Lecture 13 - Concept of Specific Energy
- Lecture 14 - Computation of Critical Depth
- Lecture 15 - Specific Force, Critical Depth & Sequent Depth
- Lecture 16 - Non-uniform Flow: Gradually Varied Flow
- Lecture 17 - Classification of Gradually Varied Flow
- Lecture 18 - Characteristic of Gradually Varied Flow
- Lecture 19 - Characteristic of Gradually Varied Flow & its Computation
- Lecture 20 - Gradually Varied Flow & its Computation
- Lecture 21 - Computation of Gradually Varied Flow
- Lecture 22 - Gradually Varied Flow: Numerical Methods and Problem Solving
- Lecture 23 - Rapidly Varied Flow: Hydraulic Jump
- Lecture 24 - Hydraulic Jump
- Lecture 25 - Flow Over Hump and Channel Contraction
- Lecture 26 - Canal Design - 1
- Lecture 27 - Canal Design - 2
- Lecture 28 - Design of Alluvial Channel - 1
- Lecture 29 - Design of Alluvial Channel - 2
- Lecture 30 - Design of Alluvial Channel - 3
- Lecture 31 - Unsteady Flow: Waves and its Classification

[Lecture 32 - Unsteady Flow Part - 2](#)

[Lecture 33 - Unsteady Flow Part - 3](#)

[Lecture 34 - Pipe Flow: Friction Loss](#)

[Lecture 35 - Pipe Flow: Losses in Pipes](#)

[Lecture 36 - Pipe in Series & Parallel](#)

[Lecture 37 - Pipe Network Analysis](#)

[Lecture 38 - Water Hammer & Surge Tank](#)

[Lecture 39 - Pipe Flow Friction Loss](#)

[Lecture 40 - Pipe Flow: Losses in Pipe](#)



Lecture 1 - Introduction to Higher Surveying

Lecture 2 - Understanding reference system, reference frame, and coordinate system for Earth

Lecture 3 - Coordinate and datum transformations

Lecture 4 - Projected coordinate system

Lecture 5 - Fundamentals of astronomy

Lecture 6 - Applications of concepts of astronomy

Lecture 7 - Time

Lecture 8 - Application of concepts of astronomy and time

Lecture 9 - Fundamental concepts of error, accuracy, and error propagation

Lecture 10 - Applications of error propagation

Lecture 11 - Observation Equation Method of adjustments

Lecture 12 - Condition Equation Method and Combined Method of adjustments

Lecture 13 - Analysis of adjustments and reporting of errors

Lecture 14 - Global Positioning System (GPS)

Lecture 15 - Introduction to Photogrammetry

Lecture 16 - Vertical photogrammetry

Lecture 17 - Stereo photogrammetry

Lecture 18 - Analytical photogrammetry - I

Lecture 19 - Analytical photogrammetry - II

Lecture 20 - Photogrammetric products

Lecture 21 - Image matching

Lecture 22 - Close range photogrammetry

Lecture 23 - Fundamentals of LiDAR

Lecture 24 - LiDAR data acquisition

Lecture 25 - Geolocation and errors of LiDAR data

Lecture 26 - Information extraction from LiDAR data

Lecture 27 - RADAR fundamentals - I

Lecture 28 - RADAR fundamentals - II

Lecture 29 - RADAR fundamentals - III

Lecture 30 - Radargrammetry

Lecture 31 - Geoscience perspective for RADAR applications

[Lecture 32 - Fundamental concepts of hydrographic survey](#)

[Lecture 33 - Field procedures for hydrographic Surveying](#)

[Lecture 34 - Modern techniques for hydrographic Survey](#)

[Lecture 35 - Navigation](#)

[Lecture 36 - Conclusive lecture](#)

Lecture 1 - Fundamental Aspects of Unsaturated Soil Mechanics and its Basic Principles

Lecture 2 - Phases of Unsaturated Soils-I

Lecture 3 - Phases of Unsaturated Soils-II

Lecture 4 - Equilibrium between Air and Water Phases

Lecture 5 - Capillary Phenomenon in Unsaturated Soils - I

Lecture 6 - Capillary Phenomenon in Unsaturated Soils - II

Lecture 7 - Summary: Fundamental Principles and Constitutive Relationships

Lecture 8 - Concept of Water Retention and Soil Water Characteristics - I

Lecture 9 - Concept of Water Retention and Soil Water Characteristics - II

Lecture 10 - Hydraulic conductivity functions and determination of state variables

Lecture 11 - Suction Measurement/Control Techniques - I

Lecture 12 - Suction Measurement/Control Techniques - II

Lecture 13 - Summary: Suction Measurement and Control Techniques

Lecture 14 - HCF Determination

Lecture 15 - SWCC and HCF Models

Lecture 16 - HCF Modelling

Lecture 17 - Fitting of SWCC and HCF modelling

Lecture 18 - Pedo-transfer Functions (PTF)

Lecture 19 - Steady-State Flow Through Soils

Lecture 20 - Steady-State and Transient Flow

Lecture 21 - Analytical Methods for Transient Flow - I

Lecture 22 - Analytical Methods for Transient Flow - II

Lecture 23 - Shear Strength of Unsaturated Soils

Lecture 24 - Suction-Controlled Direct Shear Test

Lecture 25 - Suction-Controlled Triaxial Test

Lecture 26 - Extended M-C Criterion - I

Lecture 27 - Extended M-C Criterion - II

Lecture 28 - Extended M-C Criterion - III

Lecture 29 - Concept of Suction Stress - I

Lecture 30 - Concept of Suction Stress - II

Lecture 31 - Concept of Suction Stress - III

[Lecture 32 - Summary: Shear Strength of Unsaturated Soils and Introduction to Volume Change](#)

[Lecture 33 - Swelling Behaviour of Soils](#)

[Lecture 34 - Estimation of Swelling Pressure in the Laboratory and Behaviour of Collapsible soil](#)

[Lecture 35 - Volume Change Behaviour of Bentonite and Kaolin Clay](#)

[Lecture 36 - Demonstration of Various Experiments Related to Unsaturated Soil Mechanics](#)

Lecture 1 - Introduction

Lecture 2 - Phases and classification of subsurface Investigation

Lecture 3 - Test Pits+ Borings

Lecture 4 - Ground water table and rock drilling

Lecture 5 - Standard Penetration Test

Lecture 6 - Cone Penetration Test

Lecture 7 - Dilatometer Test

Lecture 8 - Pressuremeter Test

Lecture 9 - Seismic reflection method

Lecture 10 - Seismic refraction method

Lecture 11 - Electrical Resistivity Survey

Lecture 12 - Magnetic Survey

Lecture 13 - Surface wave method

Lecture 14 - Gravity Survey

Lecture 15 - Offshore Investigation

Lecture 16 - Geophysical Investigation in Offshore Environment

Lecture 17 - Sampling and Geotechnical Investigations in Offshore Environment

Lecture 18 - Important Terminologies in Offshore Environment

Lecture 19 - Dynamic Testing in Pile Driving

Lecture 20 - Dynamic Testing in Pile (Low Strain)

Lecture 21 - Conclusion

Lecture 1 - Basic Concepts of Fluid

Lecture 2 - Properties of Fluid

Lecture 3 - Properties of Fluid

Lecture 4 - Concepts of Hydrostatic

Lecture 5 - Measurement of Pressure and Hydrostatic forces

Lecture 6 - Buoyancy, Metacentre, Stability and Rigid body motion

Lecture 7 - Reynolds Transport Theorem

Lecture 8 - Conservation of Mass

Lecture 9 - Conservation of Momentum

Lecture 10 - Conservation of Momentum Applications

Lecture 11 - Bernoulli's Equation

Lecture 12 - Applications of Bernoulli's Equation

Lecture 13 - Fluid Statics Applications: Example Problems

Lecture 14 - Conservation of Momentum: Example problems

Lecture 15 - Bernoulli's Equation: Problems Solving on Black Board

Lecture 16 - Lagrangian and Eulerian Descriptions

Lecture 17 - Motion and deformation of fluid elements

Lecture 18 - Problems Solving on Black Board

Lecture 19 - Dimensional Homogeneity

Lecture 20 - Dimensional Analysis and Similarity

Lecture 21 - Laminar and Turbulent Flows

Lecture 22 - Losses in Pipe Fittings

Lecture 23 - Flow in Noncircular Conduits and Multiple Path Pipeflow

Lecture 24 - Mass Conservation Equation - I

Lecture 25 - Mass Conservation Equation - II

Lecture 26 - Stream Function

Lecture 27 - Cauchy's Equation

Lecture 28 - The Navier-Stokes Equation - Part I

Lecture 29 - The Navier-Stokes Equation - Part II

Lecture 30 - The Navier-Stokes Equation - Part III

Lecture 31 - Approximate solutions of Navier Stokes Equation: Boundary Layer Approximation

[Lecture 32 - Boundary Layer Approximation - II](#)

[Lecture 33 - Boundary Layer Approximation - III](#)

[Lecture 34 - Open Channel Flow - I](#)

[Lecture 35 - Open Channel Flow - II](#)

[Lecture 36 - Open Channel Flow - III](#)

[Lecture 37 - Drag and Lift](#)

Lecture 1 - Overview and Introduction

Lecture 2 - Basics of Remote Sensing

Lecture 3 - Error corrections in satellite image

Lecture 4 - Error Identification and Correction - I

Lecture 5 - Error Identification and Correction - II

Lecture 6 - Error Identification and Correction - III

Lecture 7 - DIP - I

Lecture 8 - DIP - II

Lecture 9 - DIP - III

Lecture 10 - DIP - IV

Lecture 11 - Image Classification - I

Lecture 12 - Image Classification - II

Lecture 13 - Photogrammetry

Lecture 14 - Thermal Remote Sensing

Lecture 15 - Microwave Remote Sensing

Lecture 16 - HRS - I

Lecture 17 - HRS - II

Lecture 18 - HRS - III

Lecture 19 - HRS - IV

Lecture 20 - HRS - V

Lecture 21 - GIS - I

Lecture 22 - GIS - II

Lecture 23 - Applications of Remote Sensing and GIS - I

Lecture 24 - Applications of Remote Sensing and GIS - II



- Lecture 1 - Introduction to River Engineering
- Lecture 2 - Basic properties of sediment - I
- Lecture 3 - Basic properties of sediment - II
- Lecture 4 - Mass Conservation
- Lecture 5 - Linear Momentum Equation
- Lecture 6 - Navier-Stokes Equations
- Lecture 7 - St. Venant Equation and Solver
- Lecture 8 - Specific Energy and Critical Flow
- Lecture 9 - Hydraulic Jump and Celerity
- Lecture 10 - Floodwave Celerity and Loop Rating Curve
- Lecture 11 - Sediment Transport in River - I
- Lecture 12 - Sediment Transport in River - II
- Lecture 13 - Sediment Transport in River - III
- Lecture 14 - Physical River Models
- Lecture 15 - Bridge Scour: processes and estimation
- Lecture 16 - Bridge Scour-II
- Lecture 17 - Jet Scour and River Navigation
- Lecture 18 - River Training Work
- Lecture 19 - Riverbank Stabilization - I
- Lecture 20 - Riverbank Stabilization - II
- Lecture 21 - Riverbank Protection and Control Structures
- Lecture 22 - River Equilibrium - I
- Lecture 23 - River Equilibrium - II
- Lecture 24 - River Equilibrium - III

Lecture 1 - Introduction to solid waste

Lecture 2 - Functional elements

Lecture 3 - Types and sources of solid waste

Lecture 4 - Sampling and characteristics

Lecture 5 - Estimation of solid waste quantity

Lecture 6 - Factors affecting solid waste generation rate

Lecture 7 - Handling, separation and storage at source

Lecture 8 - Processing at source

Lecture 9 - Primary collection

Lecture 10 - Types of collection system

Lecture 11 - Analysis of collection system - Part I

Lecture 12 - Analysis of collection system - Part II

Lecture 13 - Analysis of collection system - Part III

Lecture 14 - Need and types of transfer station

Lecture 15 - Transport means and methods

Lecture 16 - Unit operation for component separation

Lecture 17 - Material recovery facilities (MRF)

Lecture 18 - Recycling of dry waste components

Lecture 19 - Waste as a fuel

Lecture 20 - Incineration/Combustion

Lecture 21 - Flue gas characteristics and treatment

Lecture 22 - Solid residue generation, characterization and treatment

Lecture 23 - Waste-to-energy (WtE) plants (case studies) pyrolysis and gasification

Lecture 24 - Definition and phases of composting

Lecture 25 - Factors affecting composting process

Lecture 26 - Types of composting - I

Lecture 27 - Types of composting - II

Lecture 28 - Compost quality

Lecture 29 - Vermicomposting

Lecture 30 - Definition, stages and factors affecting anaerobic digestion

Lecture 31 - Pretreatment and co-digestion for enhancement of biogas production

[Lecture 32 - Types of biogas digesters](#)

[Lecture 33 - Site selection and types of landfill](#)

[Lecture 34 - Leachate collection and treatment](#)

[Lecture 35 - Landfill gas collection and treatment](#)

[Lecture 36 - Design of landfill and Bio-minning of old dumpsite](#)

[Lecture 37 - Construction and demolition waste](#)

[Lecture 38 - Management of bio-medical, e-waste and inert waste](#)

[Lecture 39 - Integrated solid waste management \(ISWM\)](#)

[Lecture 40 - Municipal solid waste management rules](#)

[Lecture 41 - Financing in MSWM projects](#)

[Lecture 42 - Public-Private-Partnership \(PPP\)](#)

[Lecture 43 - Public-Private-Partnership \(PPP\) in MSWM projects](#)

Lecture 1 - Planning process of equipment

Lecture 2 - Estimation of Ownership cost (Average Annual Investment method)

Lecture 3 - Estimation of Ownership cost (Time value method)

Lecture 4 - Operating cost of Equipment

Lecture 5 - Equipment cost estimation

Lecture 6 - Equipment life and replacement analysis - Part 1

Lecture 7 - Equipment life and replacement analysis - Part 2

Lecture 8 - Equipment life and replacement analysis - Part 3

Lecture 9 - Engineering Fundamentals of Moving Earth

Lecture 10 - Bull Dozers

Lecture 11 - Scrapers - Part 1

Lecture 12 - Scrapers - Part 2

Lecture 13 - Front End loaders

Lecture 14 - Excavators

Lecture 15 - Trucks

Lecture 16 - Piles and Pile driving equipment - Part 1

Lecture 17 - Piles and Pile driving equipment - Part 2

Lecture 18 - Cranes - Part 1

Lecture 19 - Cranes - Part 2

Lecture 20 - Concreting Equipment - Part 1

Lecture 21 - Concreting Equipment - Part 2

Lecture 22 - Summary

- Lecture 1 - Introduction to course content
- Lecture 2 - Stress acting at a point - Cauchy stress
- Lecture 3 - Stress acting at a point - Stress tensor
- Lecture 4 - Stress acting on a plane
- Lecture 5 - Stress acting on a plane example
- Lecture 6 - Transformation of stress tensor
- Lecture 7 - Stress invariants
- Lecture 8 - Relationship between stress invariants
- Lecture 9 - Principle stresses and Eigen vectors
- Lecture 10 - Strain in soils
- Lecture 11 - Cause effect relationship
- Lecture 12 - Important constitutive relationship
- Lecture 13 - 3D to 2D idealization
- Lecture 14 - Mathematical formulation plane stress plane strain
- Lecture 15 - Mathematical formulation axisymmetric
- Lecture 16 - Summary of Module 1
- Lecture 17 - Basics of shear strength
- Lecture 18 - Stress representation
- Lecture 19 - Shear strength granular soil - I
- Lecture 20 - Shear strength granular soil - II
- Lecture 21 - Shear strength cohesive soil
- Lecture 22 - Shear strength cohesive soil - Stress strain
- Lecture 23 - Pore water pressure and Skemptions equation
- Lecture 24 - Overall pore water pressure parameter
- Lecture 25 - Pore water pressure - plane strain-effect of sampling
- Lecture 26 - Pore water pressure estimation
- Lecture 27 - Triaxial test
- Lecture 28 - Interpretation triaxial test - UU UCS
- Lecture 29 - Interpretation triaxial test - CU
- Lecture 30 - Interpretation triaxial test - CD
- Lecture 31 - Some additional aspects of shear strength

- Lecture 32 - Summary of Module 2
- Lecture 33 - Stress path and representation
- Lecture 34 - Failure line in stress path
- Lecture 35 - Stress path-some common cases - I
- Lecture 36 - Stress path-some common cases - II
- Lecture 37 - Stress path-triaxial test-drained
- Lecture 38 - Stress path-triaxial test-undrained
- Lecture 39 - Stress path-additional undrained case
- Lecture 40 - Stress path-field cases - I
- Lecture 41 - Stress path-field cases - II
- Lecture 42 - Stress path problems
- Lecture 43 - Summary of Module 3
- Lecture 44 - Introduction-critical state soil mechanics
- Lecture 45 - Introduction-critical state soil mechanics
- Lecture 46 - CSSM-2 D representation
- Lecture 47 - Peak state
- Lecture 48 - Soil yielding
- Lecture 49 - Cam clay
- Lecture 50 - Modified Cam clay
- Lecture 51 - Prediction of soil behavior from MCCM
- Lecture 52 - Prediction of soil behavior from MCCM
- Lecture 53 - Strain from MCCM
- Lecture 54 - State boundary surface
- Lecture 55 - CSSM problems
- Lecture 56 - Summary of Module 4
- Lecture 57 - Closure of Advanced Soil Mechanics Course

**NPTEL : NOC:Plates and Shells (Civil Engineering)**

**Co-ordinators : Prof. Sudip Talukdar**

- Lecture 1 - Introduction, classification of plates and some useful relations
- Lecture 2 - Theory of thin plate bending
- Lecture 3 - Plate equations and boundary conditions with examples
- Lecture 4 - Exercises on the plate bending theory
- Lecture 5 - Simply supported plate subjected to distributed loading
- Lecture 6 - Simply supported plate subjected to concentrated load and couple
- Lecture 7 - Simply supported plate resting on elastic foundation and other examples
- Lecture 8 - General formulation for rectangular plate with two opposite edges simply supported
- Lecture 9 - Levy's solution for different loading and boundary conditions
- Lecture 10 - Rectangular plate with Levy's boundary condition subjected to edge moment
- Lecture 11 - Transformation of plate equation from rectangular co-ordinates to polar co-ordinates
- Lecture 12 - Axi-symmetrical bending of circular plate under pure moment and uniformly distributed load
- Lecture 13 - Examples in axisymmetrical bending of solid and annular plate
- Lecture 14 - Variational principle in plate problem
- Lecture 15 - Applications of Rayleigh-Ritz and Gallerkin's method
- Lecture 16 - Finite difference method in plate bending
- Lecture 17 - Plate subjected to inplane forces and transverse load
- Lecture 18 - Buckling load of rectangular plate plate with Navier's boundary condition
- Lecture 19 - Buckling load of rectangular with Levy's boundary condition
- Lecture 20 - Rayleigh-Ritz and Gallerkin method in buckling of plate
- Lecture 21 - Finite difference method in buckling of plate
- Lecture 22 - Introduction to shell structure and behavior of stretched membrane
- Lecture 23 - Classification of shell structure
- Lecture 24 - Stress resultants and couples in shells
- Lecture 25 - Membrane analysis of shells of surface of revolution
- Lecture 26 - Analysis of Spherical dome
- Lecture 27 - Some examples of axi-symmetrical cases in surface of revolution
- Lecture 28 - Membrane theory in pressure vessels
- Lecture 29 - Membrane theory in pressure vessel in the form a Torus and in a tank of arbitrary meridian
- Lecture 30 - Membrane theory of hyperboloid of revolution: Application to cooling tower
- Lecture 31 - Differential Equations of Equilibrium in Cylindrical shell using membrane hypothesis

[Lecture 32 - Membrane Analysis of Cylindrical Shell roof subjected to self weight and snow load](#)

[Lecture 33 - Circular Cylindrical Shell for Fourier Loading in a membrane state of stress](#)

[Lecture 34 - Simplified Bending Theory of Cylindrical Shell-Beam and Arch theories](#)

[Lecture 35 - General bending theory of cylindrical shell](#)

[Lecture 36 - Some applications of symmetrical bending of circular cylindrical shell](#)



Lecture 1 - Introduction to Optimization

Lecture 2 - Classical Optimization

Lecture 3 - Introduction to Linear Problem

Lecture 4 - General system of equations

Lecture 5 - Simplex Method

Lecture 6 - Solution of Linear Problem using Excel Solver

Lecture 7 - Bracketing Method

Lecture 8 - Region Elimination Methods

Lecture 9 - Gradient Based Method and Examples

Lecture 10 - Convex Function

Lecture 11 - Line Search Methods for Multi-Variable Problems

Lecture 12 - Quadratic Approximation Method

Lecture 13 - Constrained Optimization I: Equality constraints

Lecture 14 - Constrained Optimization II: Inequality constraints

Lecture 15 - Constrained Optimization III: Penalty function methods

Lecture 16 - Introduction to Metaheuristic Optimization

Lecture 17 - Genetic Algorithms - Part I

Lecture 18 - Genetic Algorithms - Part II

Lecture 19 - Genetic Algorithms - Part III

Lecture 20 - Real Coded Genetic Algorithms

Lecture 21 - Multi-modal optimization

Lecture 22 - Introduction to R

Lecture 23 - GA using R (Unconstrained problem)

Lecture 24 - GA using R (Constrained problem)

Lecture 25 - Constraint Handling in GAs

Lecture 26 - Evolution Strategies (ESs)

Lecture 27 - Particle swarm optimization

Lecture 28 - Introduction to R - Part II

Lecture 29 - Multi-objective Genetic Algorithms

Lecture 30 - Introduction to Differential Evolution

Lecture 31 - Introduction to Matlab

[Lecture 32 - Optimization using Matlab \(Classical methods\)](#)

[Lecture 33 - A tutorial on Differential Evolution](#)

[Lecture 34 - NSGA II Using R](#)

[Lecture 35 - Optimization using MATLAB](#)

[Lecture 36 - Optimization using Excel Solver](#)

[Lecture 37 - Multi-objective Genetic Algorithms using MATLAB](#)

[Lecture 38 - Solution of a Design Problem Using MATLAB](#)

Lecture 1 - Course Contents

Lecture 2 - Preliminary Concepts

Lecture 3 - Introduction to Reynolds Transport Theorem

Lecture 4 - Derivation of Reynolds Transport Theorem - Part I

Lecture 5 - Derivation of Reynolds Transport Theorem - Part II

Lecture 6 - Conservations Laws

Lecture 7 - Numerical Examples

Lecture 8 - Summary of Module - I

Lecture 9 - Atmospheric Water

Lecture 10 - Water Vapor Dynamics

Lecture 11 - Precipitable Water in the Static Atmospheric Column

Lecture 12 - Numerical Examples on Basic Atmospheric Parameters

Lecture 13 - Precipitation-Types and Formation

Lecture 14 - Terminal Velocity

Lecture 15 - Thunderstorm Cell Model

Lecture 16 - Numerical Examples on Terminal Velocity and Thunderstorm Cell

Lecture 17 - Forms of Precipitation

Lecture 18 - Measurement of rainfall

Lecture 19 - Raingauge Network

Lecture 20 - Presentation of Rainfall Data

Lecture 21 - Analysis of Rainfall Data

Lecture 22 - Average Areal Rainfall

Lecture 23 - Evaporation

Lecture 24 - Evaporation-Energy Balance Method

Lecture 25 - Evaporation-Aerodynamic Method

Lecture 26 - Evaporation-Combined Method

Lecture 27 - Numerical Examples on Evaporation

Lecture 28 - Evaporation-Empirical method

Lecture 29 - Evapotranspiration

Lecture 30 - Evapotranspiration-Numerical Example

Lecture 31 - Summary of Module - II

Lecture 32 - Subsurface Water

Lecture 33 - 1-D Unsteady Unsaturated Flow Equation

Lecture 34 - Infiltration

Lecture 35 - Measurement of Infiltration

Lecture 36 - Estimation of Infiltration-Empirical Equations

Lecture 37 - Numerical examples - Infiltration estimation using empirical equations

Lecture 38 - Estimation of Infiltration-Theoretical Equation

Lecture 39 - Infiltration-Green Ampt Equation

Lecture 40 - Ponding time

Lecture 41 - Numerical Examples on Green Ampt Infiltration Equation

Lecture 42 - Summary of Module - III

Lecture 43 - Surface Water

Lecture 44 - Excess Rainfall and Direct Runoff

Lecture 45 - Numerical Examples on Direct Runoff

Lecture 46 - Overland flow

Lecture 47 - Streamflow Measurement - I

Lecture 48 - Streamflow Measurement - II

Lecture 49 - Representation of Streamflow

Lecture 50 - Numerical Examples on Streamflow Measurement

Lecture 51 - Summary of Module - IV

Lecture 52 - Hydrologic Analysis - Introduction

Lecture 53 - Linear System Theory

Lecture 54 - Hydrograph Analysis-UH

Lecture 55 - Hydrograph Analysis-DRH

Lecture 56 - Numerical examples on UH and DRH

Lecture 57 - S-Hydrograph

Lecture 58 - Unit Hydrograph of Different Duration

Lecture 59 - Numerical examples UH of Different Duration

Lecture 60 - Instantaneous Unit Hydrograph

Lecture 61 - Instantaneous Unit Hydrograph-Nash's Model

Lecture 62 - Numerical Examples on IUH

Lecture 63 - Synthetic Unit Hydrograph

Lecture 64 - SCS-Synthetic Unit Hydrograph

[Lecture 65 - Numerical Examples on SUH](#)

[Lecture 66 - Hydrograph Routing](#)

[Lecture 67 - Reservoir Routing](#)

[Lecture 68 - Numerical Example on Reservoir Routing](#)

[Lecture 69 - Hydrologic Channel Routing](#)

[Lecture 70 - Numerical Examples on Channel Routing](#)

[Lecture 71 - Summary of Module - V](#)

[Lecture 72 - Hydrologic Statistics-Preliminary Concepts](#)

[Lecture 73 - Probability Distribution and Basic Descriptive Statistics](#)

[Lecture 74 - Probability Distributions](#)

[Lecture 75 - Frequency Analysis](#)

[Lecture 76 - Extreme Value Analysis](#)

[Lecture 77 - Summary of Module - VI](#)

[Lecture 78 - Hydrologic Design](#)

[Lecture 79 - Numerical examples on probability and risk](#)

[Lecture 80 - Design Storm](#)

[Lecture 81 - Design Flood](#)

[Lecture 82 - Summary of Module - VII](#)

[Lecture 83 - Closure of Engineering Hydrology](#)

**NPTEL : NOC:Expansive Soil (Civil Engineering)**

**Co-ordinators : Prof. Anil Kumar Mishra**

Lecture 1 - Formation of soil

Lecture 2 - Index properties and classification of soil

Lecture 3 - Engineering properties of soil - I

Lecture 4 - Engineering properties of soil - II

Lecture 5 - Clay mineralogy

Lecture 6 - Properties of clay particles

Lecture 7 - Definition, type and behaviour

Lecture 8 - Mechanism of soil-water interaction

Lecture 9 - Swelling of expansive soil

Lecture 10 - Factors controlling DDL thickness

Lecture 11 - Determination of swelling properties

Lecture 12 - Classification and prediction

Lecture 13 - Factors controlling swelling of soil

Lecture 14 - Shrinkage behaviour of soil

Lecture 15 - Factors controlling shrinkage behavior of soils

Lecture 16 - Measurement of various shrinkage characteristics of soil

Lecture 17 - Cyclic Swelling-Shrinkage Behaviour of Soil

Lecture 18 - Thermo-Mechanical-Hydraulic-Chemical Behaviour - I

Lecture 19 - Thermo-Mechanical-Hydraulic-Chemical Behaviour - II

Lecture 20 - Thermo-Mechanical-Hydraulic-Chemical Behaviour - III

Lecture 21 - Mechanical Methods

Lecture 22 - Hydraulic methods

Lecture 23 - Chemical methods - 1

Lecture 24 - Chemical methods - 2

Lecture 25 - By inclusion or confinement

Lecture 26 - Foundation on expansive soil

Lecture 27 - Use of expansive soil for various geotechnical engineering applications

Lecture 28 - Closure lecture

- Lecture 1 - General Introduction and Modelling of Dynamic Systems
- Lecture 2 - Time Domain Analysis of Linear System - Harmonic input
- Lecture 3 - Time Domain Analysis of Linear System - Arbitrary Input
- Lecture 4 - Transformed technique in vibration of linear system
- Lecture 5 - Formulation of problem: Equilibrium Approach
- Lecture 6 - Formulation of problem by Energy Principle
- Lecture 7 - Hamilton's principles for formulating vibration problems
- Lecture 8 - Lagrange's equation for formulating vibration problems
- Lecture 9 - One Dimensional Wave Equation
- Lecture 10 - D'Alembert's Solution of the Wave Equation
- Lecture 11 - Transverse Vibration of String
- Lecture 12 - Forced Transverse Vibration of String
- Lecture 13 - Axial Vibration of Bar
- Lecture 14 - Torsional Vibration of Bar
- Lecture 15 - Some typical problems in axial and torsional vibrations
- Lecture 16 - Transverse vibration of beams
- Lecture 17 - Natural frequencies and mode shapes of beams with various end conditions
- Lecture 18 - Free damped transverse vibration analysis of beam
- Lecture 19 - Forced damped vibration analysis of Euler Bernoulli beam
- Lecture 20 - Vibration of beams subjected to moving load
- Lecture 21 - Some special topics on the transverse vibration of beam
- Lecture 22 - Combination of continuous and lumped parameter system
- Lecture 23 - State space solutions in vibration problems
- Lecture 24 - Beam with moving oscillator, pulsating force and rolling mass
- Lecture 25 - Vibration of membrane
- Lecture 26 - Vibration of Circular membrane
- Lecture 27 - Vibration of Rectangular plate
- Lecture 28 - Free vibration of rectangular plates
- Lecture 29 - Forced vibration of rectangular plates
- Lecture 30 - Approximate method for vibration analysis
- Lecture 31 - Rayleigh-Ritz method for vibration analysis

[Lecture 32 - Gallerkin's method and Finite difference method](#)

[Lecture 33 - System subjected to support excitation](#)

[Lecture 34 - Response of continuous systems to transient excitations](#)

[Lecture 35 - Shock spectrum due to half sine pulse](#)

[Lecture 36 - Numerical Evaluation of Duhamel Integral](#)

[Lecture 37 - Direct Integration Methods](#)

[Lecture 38 - Spectral Analysis of structures for earthquake excitation](#)



Lecture 1 - Introduction

Lecture 2 - Random Variable

Lecture 3 - Functions of Random Variables

Lecture 4 - Joint Distributions

Lecture 5 - Mt. Gen. Func. and CLT

Lecture 6 - Theory of Estimation

Lecture 7 - Goodness of Fit

Lecture 8 - MVFOSM

Lecture 9 - MVFOSM (Continued...)

Lecture 10 - Hasofer-Lind Rel. Index

Lecture 11 - Rackwitz's Algorithm (Continued...)

Lecture 12 - HL-RF for Non-Normal Problems

Lecture 13 - HL-RF for Correlated Problems

Lecture 14 - FORM using MATLAB

Lecture 15 - FORM using MATLAB (Continued...)

Lecture 16 - FORM Using FEM

Lecture 17 - Morgenstern Model

Lecture 18 - Nataf Model

Lecture 19 - Rosenblatt Transformation

Lecture 20 - Brietung's Model

Lecture 21 - Tvedt's Model

Lecture 22 - Monte-Carlo Simulation

Lecture 23 - Importance Sampling

Lecture 24 - Least Square Curve Fitting

Lecture 25 - Orthogonal Polynomials

Lecture 26 - RSM

Lecture 27 - Stochastic Response Surface Method

Lecture 28 - Moving Least Square Method

Lecture 29 - Adaptive-SRSM

Lecture 30 - Partial Safety Factors

Lecture 31 - Optimal Partial Safety Factors

[Lecture 32 - FORM - Revisited](#)

[Lecture 33 - Subset Simulation](#)

[Lecture 34 - Applications](#)

[Lecture 35 - Applications \(Continued...\)](#)

[Lecture 36 - Introduction to Stochastic FEM](#)

- Lecture 1 - Plate tectonics and continental drift theory
- Lecture 2 - Fault Plane Solution - Part 1
- Lecture 3 - Fault Plane Solution - Part 2
- Lecture 4 - Fault Plane Solution (Stereonets)
- Lecture 5 - Seismic gaps
- Lecture 6 - Analogy of active and inactive fault
- Lecture 7 - Seismic waves and their use in locating EQ epicentre
- Lecture 8 - EQ Intensity, magnitude and wave attenuation
- Lecture 9 - Seismic source characterization and seismic activity
- Lecture 10 - Earthquake catalogue preparation and seismic activity parameters
- Lecture 11 - Ground motion simulation models and GMPEs
- Lecture 12 - Deterministic seismic hazard analysis (DSHA)
- Lecture 13 - Probabilistic seismic hazard analysis (PSHA)
- Lecture 14 - One Dimensional equation of motion: P wave
- Lecture 15 - One Dimensional equation of motion: S wave
- Lecture 16 - Solution to 1D equation of motion: S wave
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**NPTEL : Advanced Hydrology (Civil Engineering)**

**Co-ordinators : Dr. Ashu Jain**

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**NPTEL : Environmental Air Pollution (Civil Engineering)**

**Co-ordinators : Prof. Mukesh Sharma**

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- Lecture 3 - Air Quality Standards
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- Lecture 5 - Measurement Units and Particulate classification
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- Lecture 10 - Kinetics of Air pollution and combustion processes
- Lecture 11 - Internal Combustion Engine and Air Pollution - I
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**NPTEL : Water Resources Engineering (Civil Engineering)**

**Co-ordinators : Dr. Pranab K Mohapatra, Prof. Rajesh Srivastava**

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**NPTEL : Application of Soil Mechanics (Civil Engineering)**

**Co-ordinators : Dr. Nihar Ranjan Patra**

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- Lecture 9 - Lecture 9 - Introduction (Concrete Mixture Proportioning Strategies)
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- Lecture 24 - Lecture 31 - From paste to concrete
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Lecture 3 - Conditions of equilibrium in 2D and 3D

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Lecture 19 - Concept of Stress

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- Lecture 54 - Load Deflection Differential Equation
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- Lecture 57 - Introduction to Concept of Elastic Instability
- Lecture 58 - Critical Load
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- Lecture 5 - Resource management in construction projects
- Lecture 6 - Estimating quantities
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- Lecture 8 - Estimation of project cost
- Lecture 9 - Discussion on the case study of boundary wall
- Lecture 10 - Running account bills
- Lecture 11 - Economic decision making in construction projects
- Lecture 12 - Depreciation of construction equipment
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- Lecture 14 - Introduction to planning and scheduling
- Lecture 15 - Introduction to planning and scheduling (Continued...)
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[Lecture 39 - Optically Stimulated Luminescence \(OSL\) Dating Lab](#)

Lecture 1 - Introduction

Lecture 2 - Soil Exploration

Lecture 3 - Soil Exploration - Penetration Tests

Lecture 4 - Soil Exploration - Geophysical Exploration

Lecture 5 - Shallow Foundation - Introduction

Lecture 6 - Shallow Foundation : Bearing Capacity - I

Lecture 7 - Shallow Foundation : Bearing Capacity - II

Lecture 8 - Shallow Foundation : Bearing Capacity - III

Lecture 9 - Shallow Foundation : Bearing Capacity - IV

Lecture 10 - Shallow Foundation : Bearing Capacity - V

Lecture 11 - Shallow Foundation - Settlement Calculation - I

Lecture 12 - Shallow Foundation - Settlement Calculation - II

Lecture 13 - Shallow Foundation - Settlement Calculation - III

Lecture 14 - Design of Shallow Foundation

Lecture 15 - Design of Raft Foundation

Lecture 16 - Deep Foundation - Introduction

Lecture 17 - Pile Foundation - Load Carrying Capacity - I

Lecture 18 - Pile Foundation - Load Carrying Capacity - II

Lecture 19 - Pile Foundation - Load Carrying Capacity - III and Settlement Calculation

Lecture 20 - Tension and Lateral Loaded Piles

Lecture 21 - Well Foundation

Lecture 22 - Well Foundation (Continued...)

Lecture 23 - Design of Retaining Wall

Lecture 24 - Design of Retaining Wall (Continued...)

Lecture 25 - Design of Sheet Piles

Lecture 26 - Design of Sheet Piles (Continued...)

Lecture 27 - Design of Sheet Piles (Continued...)

Lecture 28 - Design of Sheet Piles (Continued...)

Lecture 29 - Reinforced Earth

Lecture 30 - Reinforced Retaining Wall

Lecture 31 - Seismic Design of Retaining Wall



[Lecture 32 - Seismic Design of Retaining Walls \(Continued...\)](#)

[Lecture 33 - Soil - Foundation Interaction](#)

[Lecture 34 - Soil - Foundation Interaction \(Continued...\)](#)

[Lecture 35 - Soil - Foundation Interaction \(Continued...\)](#)

[Lecture 36 - Soil - Foundation Interaction \(Continued...\)](#)

[Lecture 37 - Soil - Foundation Interaction \(Continued...\)](#)

[Lecture 38 - Soil - Foundation Interaction \(Continued...\)](#)

[Lecture 39 - Soil - Foundation Interaction \(Continued...\)](#)

[Lecture 40 - Soil - Foundation Interaction \(Continued...\)](#)

**NPTEL : Ground Water Hydrology (Civil Engineering)**

**Co-ordinators : Dr. Anirban Dhar, Dr. V.R. Desai**

- Lecture 1 - Introduction : Ground Water (GW) Utilization and Historical Background, GW in hydrologic Cycle
- Lecture 2 - Ground Water in & % Hydrologic Cycle (Continued...), Ground Water Budget, Ground Water Level Fluctuations and Environmental Influence
- Lecture 3 - Ground water Level Fluctuations and Environmental Influence (Continued...) Literature/Data/Internet Resources
- Lecture 4 - Ground water Level Fluctuations and Environmental Influence (Continued...) Literature/Data/Internet Resources
- Lecture 5 - Occurrence and Movement of Ground Water : Origin and Age of Ground Water, Rock Properties Affecting Ground Water, Ground Water Column
- Lecture 6 - Zones of Aeration and Saturation; Aquifers and their characteristics/classification
- Lecture 7 - Aquifer Classification (Continued...), Ground water Basins and Springs; Darcy's Law; Permeability
- Lecture 8 - Determination of Permeability : Heterogeneity and Anisotropy
- Lecture 9 - Ground Water (GW) flowrates and flow directions; general flow equations through porous media
- Lecture 10 - General Flow Equations Through Porous Media (Continued...), Dupuit's Assumptions
- Lecture 11 - 1-D Unconfined Ground water Flows; Steady Flow into Wells
- Lecture 12 - Steady Flow into Wells (Continued...); Unsteady Flow into Wells
- Lecture 13 - Unsteady Flow into Wells (Continued...)
- Lecture 14 - Unsteady Radial Flow in Confined and Unconfined Aquifers
- Lecture 15 - Unsteady Radial Flow in Leaky Aquifers (Continued...); Well Flow Near Aquifer Boundaries
- Lecture 16 - Well Flow for Special Conditions; Partially Penetrating Wells; Horizontal Wells and Collector Wells; Multiple Well Systems
- Lecture 17 - Well Completion; Well Development; Well Protection; Well Rehabilitation; Well testing for Yields
- Lecture 18 - Well Protection/Rehabilitation/Testing for yield (Continued...); Artificial Ground Water Recharge : Concept and Methods
- Lecture 19 - Concept and methods of Artificial Ground Water Recharge (Continued...); Recharge Mounds and Induced Recharge
- Lecture 20 - Induced Recharge (Continued...); Wastewater recharge for reuse; Water spreading
- Lecture 21 - Pollution and Quality Analysis of Ground Water : Sources of Pollution of GW-Municipal, Industrial, Agricultural and Miscellaneous
- Lecture 22 - Ground Water Pollution from Industrial, Agricultural and Miscellaneous Sources (Continued...)
- Lecture 23 - Ground Water Pollution from Miscellaneous Sources (Continued...), Attenuation and Underground Distribution of Pollutants
- Lecture 24 - Potential Evaluation of Ground water Pollution; Physical/Chemical/Biological analysis of Ground Water quality; Criteria and measures of Ground water quality
- Lecture 25 - Ground water salinity and samples ; Graphical representations of ground water quality
- Lecture 26 - Graphical representations of ground water quality (Continued...), Surface/Sub-Surface Investigation Of Ground Water: Geological/geophysical exploration; Remote sensing/electrical resistivity methods
- Lecture 27 - Surface Investigation of ground water (Continued...): Electrical resistivity seismic refraction/gravity/magnetic methods

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Lecture 28 - Seismic refraction/gravity/magnetic methods (Continued...);Sub-surface investigation of ground water: Geographical/resistivity methods

Lecture 29 - Sub-surface investigation of ground water (Continued...): Geographical/resistivity/spontaneous potential/radiation of methods of logging

Lecture 30 - Radiation method of logging (Continued...); Temperature/caliper/fluid conductivity/fluid velocity/miscellaneous logging methods

Lecture 31 - Saline Water Intrusion in Aquifers:Occurence, Features affecting aquifers,Bodon - Ghyben - Hergberg Principle

Lecture 32 - Saline Water Intrusion in Aquifers : Bodon - Ghyben - Hergberg principle (Continued...), Analytical Solution of Saline Water Intrusion in Coastal Aquifer

Lecture 33 - Saline Water Intrusion in Aquifers : Analytical Solution of Saline Water Intrusion in Coastal Aquifer (Continued...), Density dependent salt water intrusion model

Lecture 34 - Saline Water Intrusion in Aquifers : Geochemical Investigations, Control of salt water intrusion, Practical Modeling of salt water intrusion

Lecture 35 - Modeling and Management of Ground Water : Ground Water Simulation Models, Ground Water Management Model : Confined Aquifer

Lecture 36 - Modeling and Management of Ground Water : Ground Water Management Model : Confined and Unconfined Aquifer, Linked Simulation - Optimization, Meta Model Based Approach

Lecture 37 - Modeling and Management of Ground Water : Contaminant Source Identification , Monitoring Network Design

Lecture 38 - Modeling and Management of Ground Water : Aquifer Yield and Ground Water Availability, Effects of Ground Water Development, Regional Scale Development of Ground Water

Lecture 39 - Modeling and Management of Ground Water : Conjunctive Surface - Subsurface Modeling of Overland Flow including flow through Vadose zone

Lecture 40 - Modeling and Management of Ground Water : Ground Water - Surface Water Interaction

Lecture 1 - Introduction to Numerical Methods

Lecture 2 - Error Analysis

Lecture 3 - Introduction to Linear Systems - I

Lecture 4 - Linear Systems - II

Lecture 5 - Linear Systems - III

Lecture 6 - Linear Systems - Error Bounds

Lecture 7 - Error Bounds and Iterative Methods for Solving Linear Systems

Lecture 8 - Iterative Methods for Solving Linear Systems - I

Lecture 9 - Iterative Methods - II

Lecture 10 - Iterative Methods - III

Lecture 11 - Iterative Methods for Eigen Value Extraction

Lecture 12 - Solving Nonlinear Equations - I

Lecture 13 - Solving Nonlinear Equations - II

Lecture 14 - Solving Multi Dimensional Nonlinear Equations - I

Lecture 15 - Solving Multi Dimensional Nonlinear Equations - II

Lecture 16 - ARC Length and Gradient Based Methods

Lecture 17 - Gradient Based Methods

Lecture 18 - Conjugate Gradient Method - I

Lecture 19 - Conjugate Gradient Method - II

Lecture 20 - Nonlinear Conjugate Gradient and Introduction to PDEs

Lecture 21 - Eigenfunction Solutions for the Wave Equation

Lecture 22 - Analytical Methods for Solving the Wave Equation

Lecture 23 - Analytical Methods for Hyperbolic and Parabolic PDEs

Lecture 24 - Analytical Methods for Parabolic and Elliptic PDEs

Lecture 25 - Analytical Methods for Elliptic PDE's

Lecture 26 - Series Solutions for Elliptic PDE's and Introduction to Differential Operators

Lecture 27 - Differential Operators - I

Lecture 28 - Differential Operators - II

Lecture 29 - Differential Operators - III

Lecture 30 - Interpolation

Lecture 31 - Polynomial Fitting

[Lecture 32 - Orthogonal Polynomials - I](#)

[Lecture 33 - Orthogonal Polynomials - II](#)

[Lecture 34 - Orthogonal Polynomials - III](#)

[Lecture 35 - Spline Functions](#)

[Lecture 36 - Orthogonal Basis Functions for Solving PDE's - I](#)

[Lecture 37 - Orthogonal Basis Functions for Solving PDE's - II](#)

[Lecture 38 - Integral Equations - I](#)

[Lecture 39 - Integral Equations - II](#)

[Lecture 40 - Integral Equations - III](#)

Lecture 1 - Introduction - Role of Probability in Civil Engineering

Lecture 2 - Random Events and Probability Concept

Lecture 3 - Set Theory and Set Operations

Lecture 4 - Axioms of Probability

Lecture 5 - Probability of Events

Lecture 6 - Concept and Definition of Random Variables

Lecture 7 - Probability Distribution of Random Variables

Lecture 8 - CDF and Descriptors of Random Variables

Lecture 9 - Further Descriptors of Random Variables

Lecture 10 - Discrete Probability Distribution

Lecture 11 - Probability Distribution of Continuous RVs

Lecture 12 - Probability Distribution of Continuous RVs (Continued...1)

Lecture 13 - Probability Distribution of Continuous RVs (Continued...2)

Lecture 14 - Functions of Single Random Variables

Lecture 15 - Functions of Random Variables - Different Methods

Lecture 16 - Functions of Random Variables - Different Methods (Continued...)

Lecture 17 - Expectation and Moments of Functions of RV

Lecture 18 - Expectation and Moments of Functions of RV (Continued...)

Lecture 19 - Joint Probability Distribution

Lecture 20 - Marginal Probability Distribution

Lecture 21 - Conditional Probability Distribution

Lecture 22 - Conditional Probability Distribution (Continued...)

Lecture 23 - Properties of Multiple Random Variables

Lecture 24 - Properties of Multiple Random Variables (Continued...)

Lecture 25 - MGF of Multivariate RVs and Multivariate Probability Distributions

Lecture 26 - Multivariate Distribution and Functions of Multiple Random Variables

Lecture 27 - Functions of Multiple Random Variables (Continued...1)

Lecture 28 - Functions of Multiple Random Variables (Continued...2)

Lecture 29 - Introduction to Copulas

Lecture 30 - Introduction to Copulas (Continued...)

Lecture 31 - Probability Models using Normal Distribution

[Lecture 32 - Probability Models using Log Normal and Exponential Distribution](#)

[Lecture 33 - Probability Models using Gamma and Extreme Value Distribution](#)

[Lecture 34 - Probability Models using Discrete Probability Distributions](#)

[Lecture 35 - Sampling Distribution and Parameter Estimation](#)

[Lecture 36 - Sampling Distribution and Parameter Estimation \(Continued...\)](#)

[Lecture 37 - Hypothesis Testing](#)

[Lecture 38 - Goodness - of - fit tests](#)

[Lecture 39 - Regression Analyses and Correlation](#)

[Lecture 40 - Regression Analyses and Correlation \(Continued...\)](#)

Lecture 1 - Introduction - I

Lecture 2 - Materials

Lecture 3 - Different Methods of Design of Reinforced Concrete Structures

Lecture 4 - Working Stress Method

Lecture 5 - Working Stress Method (Continued...)

Lecture 6 - Limit State of Collapse Flexure - I

Lecture 7 - Limit State of Collapse Flexure - II

Lecture 8 - Design of Doubly Reinforced Beam Flexure - I

Lecture 9 - Design of Doubly Reinforced Beam Flexure - II

Lecture 10 - Design of Doubly Reinforced Beam Flexure

Lecture 11 - Limit State of Collapse Shear

Lecture 12 - Design for Shear

Lecture 13 - Design for Shear (Continued...)

Lecture 14 - Design of Slabs - Part I

Lecture 15 - Design of Slabs - Part II

Lecture 16 - Design of Slabs - Part III

Lecture 17 - Design of Slabs - Part IV

Lecture 18 - Design of Slabs - Part V

Lecture 19 - Design of Columns - Part I

Lecture 20 - Design of Columns - Part II

Lecture 21 - Design of Columns - Part III

Lecture 22 - Design of Columns - Part IV

Lecture 23 - Design of Columns - Part V

Lecture 24 - Design of Footings - Part I

Lecture 25 - Design of Footings - Part II

Lecture 26 - Design of Staircases

Lecture 27 - Design for Torsion - Part I

Lecture 28 - Design for Torsion - Part II

Lecture 29 - Design of RC Slender Columns

Lecture 30 - Deflection of RC Beams



**NPTEL : Engineering Geology (Civil Engineering)**

**Co-ordinators : Dr. Debasis Roy**

- Lecture 1 - Introduction to Engineering Geology
- Lecture 2 - Geologic Structures
- Lecture 3 - Geologic Maps and Stratigraphic Sections
- Lecture 4 - Remote Sensing in Engineering Geology
- Lecture 5 - Physical Properties of Minerals
- Lecture 6 - Crystallography and Optical Properties
- Lecture 7 - Chemical Characteristics of Minerals
- Lecture 8 - Origin And Types of Rocks
- Lecture 9 - Origin And Types of Soils
- Lecture 10 - Igneous Rocks
- Lecture 11 - Sedimentary Rocks
- Lecture 12 - Metamorphic Rocks
- Lecture 13 - Weathering
- Lecture 14 - Sediment Transport and Deposition
- Lecture 15 - Introduction to Subsurface Exploration
- Lecture 16 - Introduction to Subsurface Exploration
- Lecture 17 - Sampling and Non - Intrusive Methods
- Lecture 18 - Index Properties and Classification of Soils
- Lecture 19 - Index Properties of Rock and Rock Mass
- Lecture 20 - Stress-Strain Behavior of Soil and Rock - I
- Lecture 21 - Stress-Strain Behavior of Soil and Rock - II
- Lecture 22 - In-situ State of Stress
- Lecture 23 - Geologic Considerations in Tunneling
- Lecture 24 - Geologic Considerations in Dam Construction
- Lecture 25 - Groundwater - Preliminaries
- Lecture 26 - Groundwater Flow - I
- Lecture 27 - Groundwater Flow - II
- Lecture 28 - Groundwater Related Engineering Issues
- Lecture 29 - Groundwater Over Utilization
- Lecture 30 - Plate Tectonics
- Lecture 31 - Plate Tectonics - 2 and Earthquake

[Lecture 32 - Earthquake Hazard Assessment](#)

[Lecture 33 - Geologic Hazards - Seismicity and Volcanism](#)

[Lecture 34 - Geologic Hazards - Shoreline Processes](#)

[Lecture 35 - Geologic Hazards - Shoreline Processes](#)

[Lecture 36 - Geologic Hazards - Landslide Hazards - Zoning](#)

[Lecture 37 - Geologic Hazards Subsidence , Collapsible Soils](#)

[Lecture 38 - Preparation of Geologic Sections](#)

[Lecture 39 - Index testing of soil & rocks](#)

[Lecture 40 - Identification of minerals and rock samples](#)

**NPTEL : Introduction to Transportation Engineering (Civil Engineering)**

**Co-ordinators : Dr. K.S. Reddy, Dr. Bhargab Maitra**

- Lecture 1 - Transportation Engineering
- Lecture 2 - Elements of Concern and Components
- Lecture 3 - Traffic Stream Characteristics
- Lecture 4 - Traffic Studies : Part - I
- Lecture 5 - Traffic Studies : Part - II
- Lecture 6 - Highway Capacity and Level of Service
- Lecture 7 - Intersection Control and Signalization
- Lecture 8 - Functional Classification, Design Elements
- Lecture 9 - Cross Section Elements
- Lecture 10 - Stopping Sight Distance And Decision Sight
- Lecture 11 - Overtaking, Intermediate and Headlight Sight
- Lecture 12 - Intersection Sight Distance - I
- Lecture 13 - Intersection Sight Distance - II
- Lecture 14 - Horizontal Alignment - I
- Lecture 15 - Horizontal Alignment - II
- Lecture 16 - Horizontal Alignment - III
- Lecture 17 - Horizontal Alignment - IV
- Lecture 18 - Horizontal Alignment - V
- Lecture 19 - Horizontal Alignment - VI
- Lecture 20 - Vertical Alignment - I
- Lecture 21 - Vertical Alignment - II
- Lecture 22 - Vertical Alignment - III
- Lecture 23 - Highway Alignment
- Lecture 24 - Principles of Pavement Design
- Lecture 25 - Traffic Loading - I
- Lecture 26 - Traffic Loading - II
- Lecture 27 - Pavement Materials - I
- Lecture 28 - Pavement Materials - II
- Lecture 29 - Pavement Materials - III
- Lecture 30 - Pavement Materials - IV
- Lecture 31 - Pavement Materials - V

[Lecture 32 - Design of Bituminous Mixes - I](#)

[Lecture 33 - Design of Bituminous Mixes - II](#)

[Lecture 34 - Analysis of Flexible Pavements](#)

[Lecture 35 - Analysis of Concrete Pavements](#)

[Lecture 36 - Flexible Pavement Design Indian Roads Congress](#)

[Lecture 37 - Flexible Pavement Design AASHTO Method - 1993](#)

[Lecture 38 - Concrete Pavement Design Indian Congress Method](#)

[Lecture 39 - Concrete Pavement Design PCA and AASHTO Methods](#)

[Lecture 40 - Pavement Evaluation and Rehabilitation](#)

[Lecture 41 - Overlay Design - IRC Method](#)

**NPTEL : Strength of Materials (Civil Engineering)**

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

Lecture 1 - Introduction - Strength of Materials

Lecture 2 - Analysis of Stress - I

Lecture 3 - Analysis of Stress - II

Lecture 4 - Analysis of Stress - III

Lecture 5 - Analysis of Stress - IV

Lecture 6 - Analysis of Stress - V

Lecture 7 - Analysis of Strain - I

Lecture 8 - Analysis of Strain - II

Lecture 9 - Analysis of Strain - III

Lecture 10 - Analysis of Strain - IV

Lecture 11 - Analysis of Strain - V

Lecture 12 - Analysis of Strain - VI

Lecture 13 - Analysis of Strain - VII

Lecture 14 - Analysis of Strain - VIII

Lecture 15 - Application of Stress/Strain

Lecture 16 - Application of Stress / Strain

Lecture 17 - Application of Stress / Strain

Lecture 18 - Torsion - I

Lecture 19 - Torsion - II

Lecture 20 - Torsion - III

Lecture 21 - Torsion - IV

Lecture 22 - Bending of Beams - I

Lecture 23 - Bending of Beams - II

Lecture 24 - Bending of Beams - III

Lecture 25 - Bending of Beams - IV

Lecture 26 - Stresses in Beams - I

Lecture 27 - Stresses in Beams - II

Lecture 28 - Stresses in Beams - III

Lecture 29 - Stresses in Beams - IV

Lecture 30 - Deflection of Beams - I

Lecture 31 - Deflection of Beams - II

[Lecture 32 - Deflection of Beams - III](#)

[Lecture 33 - Deflection of Beams - IV](#)

[Lecture 34 - Combined Stresses - I](#)

[Lecture 35 - Combined Stresses - II](#)

[Lecture 36 - Combined Stresses - III](#)

[Lecture 37 - Stability of Columns - I](#)

[Lecture 38 - Stability of Columns - II](#)

[Lecture 39 - Springs - I](#)

[Lecture 40 - Springs - II](#)

- Lecture 1 - Random Events and Probability Concept
- Lecture 2 - Set Theory and Set Operations
- Lecture 3 - Axioms of Probability
- Lecture 4 - Probability of Events
- Lecture 5 - Concept and definition of Random variables
- Lecture 6 - Probability distribution of random variables
- Lecture 7 - CDF and Descriptors of Random Variables
- Lecture 8 - Further Descriptors of Random Variables
- Lecture 9 - Discrete Probability Distribution
- Lecture 10 - Probability Distribution of Continuous RVs
- Lecture 11 - Probability Distribution of Continuous RVs (Continued.....1)
- Lecture 12 - Probability Distribution of Continuous RVs (Continued.....2)
- Lecture 13 - Functions of Single Random Variables
- Lecture 14 - Functions of Different Variables - Different Methods
- Lecture 15 - Functions of Random Variables : Different Methods (Continued...)
- Lecture 16 - Probability Models using Normal Distribution
- Lecture 17 - Probability Models using Log Normal and Exponential Distribution
- Lecture 18 - Probability Models using Gamma and Extreme Value Distribution
- Lecture 19 - Probability Models using Discrete Probability Distributions
- Lecture 20 - Sampling Distribution and Parameter Estimation
- Lecture 21 - Sampling Distribution and Parameter Estimation (Continued...)
- Lecture 22 - Hypothesis Testing
- Lecture 23 - Goodness of Fit-Tests
- Lecture 24 - Regression Analyses and Correlation
- Lecture 25 - Regression Analyses and Correlation (Continued...)

- Lecture 1 - Visual Semantics for Visual Communication
- Lecture 2 - Visual Semantics for Visual Communication (Continued...)
- Lecture 3 - Visual Semantics for Visual Communication (Continued...)
- Lecture 4 - Visual Semantics for Visual Communication (Continued...)
- Lecture 5 - Introduction to Millimeter-Wave Technology (Continued...)
- Lecture 6 - Visual Semantics for Visual Communication (Continued...)
- Lecture 7 - Visual Semantics for Visual Communication (Continued...)
- Lecture 8 - Visual Semantics for Visual Communication (Continued...)
- Lecture 9 - Introduction to Millimeter-Wave Technology
- Lecture 10 - Visual Semantics for Visual Communication (Continued...)
- Lecture 11 - Visual Semantics for Visual Communication (Continued...)
- Lecture 12 - Visual Semantics for Visual Communication (Continued...)
- Lecture 13 - Conceptual Model and Affordances
- Lecture 14 - Visual Semantics for Visual Communication (Continued...)
- Lecture 15 - Visual Semantics for Visual Communication (Continued...)
- Lecture 16 - Visual Semantics for Visual Communication (Continued...)
- Lecture 17 - Visual Semantics for Visual Communication (Continued...)
- Lecture 18 - Visual Semantics for Visual Communication (Continued...)
- Lecture 19 - Visual Semantics for Visual Communication (Continued...)
- Lecture 20 - Visual Semantics for Visual Communication (Continued...)



[Lecture 1 - Life Cycle Assessment - Introduction](#)

[Lecture 2 - Life Cycle Assessment - Introduction](#)

[Lecture 3 - LCA and Sustainability](#)

[Lecture 4 - LCA and Environmental Systems](#)

[Lecture 5 - LCA and Water, Food and Energy](#)

[Lecture 6 - RISK Assessment and LCA Frameworks](#)

[Lecture 7 - RISK Assessment - Toxicology](#)

[Lecture 8 - RISK Assessment Methods](#)

[Lecture 9 - RISK Assessment Methods \(Continued...\)](#)

[Lecture 10 - Environmental Risk Assessment](#)

[Lecture 11 - Environmental Data Collection and LCA Methodology](#)

[Lecture 12 - Environmental Data Collection and LCA Methodology \(Continued...\)](#)

[Lecture 13 - Environmental Data Collection and LCA Methodology \(Continued...\)](#)

[Lecture 14 - Environmental Data Collection and LCA Methodology \(Continued...\)](#)

[Lecture 15 - LCA Methodology](#)

[Lecture 16 - LCA - A Detailed Methodology](#)

[Lecture 17 - LCA - A Detailed Methodology \(Continued...\)](#)

[Lecture 18 - LCA Benefits and Drawbacks](#)

[Lecture 19 - History of LCA](#)

[Lecture 20 - The ISO Framework](#)

[Lecture 21 - Unit Process, Data and LCI Databases](#)

[Lecture 22 - Unit Process and System Boundary \(Continued...\)](#)

[Lecture 23 - Inventory Data and LCIA](#)

[Lecture 24 - LCIA](#)

[Lecture 25 - LCA Interpretation](#)

[Lecture 26 - ISO 14040](#)

[Lecture 27 - Key Points of a Good LCA and Example LCA](#)

[Lecture 28 - Chemical Release in Environment](#)

[Lecture 29 - Green Sustainable Materials](#)

[Lecture 30 - Green Sustainable Materials \(Continued...\)](#)

[Lecture 31 - Design for Sustainability](#)

[Lecture 32 - Design for Sustainability \(Continued...\)](#)

[Lecture 33 - Design for Sustainability \(Continued...\)](#)

[Lecture 34 - Sustainable Engineering Design Principles](#)

[Lecture 35 - Sustainable Engineering Design Principles \(Continued...\)](#)

[Lecture 36 - Summary and Case Studies](#)

[Lecture 37 - Summary and Case Studies \(Continued...\)](#)

[Lecture 38 - Summary and Case Studies \(Continued...\)](#)

[Lecture 39 - Tutorial I](#)

[Lecture 40 - Tutorial II](#)

[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 - Municipal Solid Waste Characteristics and Quantities](#)

[Lecture 8 - Municipal Solid Waste Characteristics and Quantities \(Continued...\)](#)

[Lecture 9 - Municipal Solid Waste Characteristics and Quantities \(Continued...\)](#)

[Lecture 10 - Municipal Solid Waste Characteristics and Quantities \(Continued...\)](#)

[Lecture 11 - MSW Characteristics - Thermal Properties and Chemical Composition](#)

[Lecture 12 - Chemical Analysis Procedure](#)

[Lecture 13 - Chemical Analysis Procedure \(Continued...\)](#)

[Lecture 14 - Working with Data and Statistical Methods](#)

[Lecture 15 - Waste Management Rules 2016](#)

[Lecture 16 - Waste Management Rules 2016 \(Continued...\)](#)

[Lecture 17 - Swachh Bharat Mission and Smart Cities Program Overview](#)

[Lecture 18 - Storage of Solid Waste](#)

[Lecture 19 - MSW Collection System](#)

[Lecture 20 - MSW Collection System \(Continued...\)](#)

[Lecture 21 - Waste Collection and Transport](#)

[Lecture 22 - Waste Collection and Transport \(Continued...\)](#)

[Lecture 23 - Waste Collection and Transport \(Continued...\)](#)

[Lecture 24 - Waste Collection and Transport \(Continued...\)](#)

[Lecture 25 - Waste Collection and Transport \(Continued...\)](#)

[Lecture 26 - Collection System](#)

[Lecture 27 - Collection System \(Continued...\)](#)

[Lecture 28 - Review of MSW Management in Proposed Smart Cities](#)

[Lecture 29 - Biological Treatment of Waste](#)

[Lecture 30 - Biological Treatment of Waste \(Continued...\)](#)

[Lecture 31 - Biological Treatment of Waste \(Continued...\)](#)

- [Lecture 32 - Biological Treatment of Waste \(Continued...\)](#)
- [Lecture 33 - Biological Treatment of Waste \(Continued...\)](#)
- [Lecture 34 - Thermal Treatment](#)
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- [Lecture 36 - Thermal Treatment \(Continued...\)](#)
- [Lecture 37 - Thermal Treatment \(Continued...\)](#)
- [Lecture 38 - Thermal Treatment \(Continued...\)](#)
- [Lecture 39 - Thermal Treatment \(Continued...\)](#)
- [Lecture 40 - Landfill Disposal](#)
- [Lecture 41 - Landfill Disposal \(Continued...\)](#)
- [Lecture 42 - Landfill Disposal \(Continued...\)](#)
- [Lecture 43 - Landfill Disposal \(Continued...\)](#)
- [Lecture 44 - Landfill Disposal \(Continued...\)](#)
- [Lecture 45 - Landfill Disposal \(Continued...\)](#)
- [Lecture 46 - Landfill Disposal \(Continued...\)](#)
- [Lecture 47 - Landfill Disposal \(Continued...\)](#)
- [Lecture 48 - Construction and Demolition Waste Management](#)
- [Lecture 49 - Construction and Demolition Waste Management \(Continued...\)](#)
- [Lecture 50 - Construction and Demolition Waste Management \(Continued...\)](#)
- [Lecture 51 - Construction and Demolition Waste Management \(Continued...\)](#)
- [Lecture 52 - Construction and Demolition Waste Management \(Continued...\)](#)
- [Lecture 53 - E-Waste Management](#)
- [Lecture 54 - E-Waste Management \(Continued...\)](#)
- [Lecture 55 - E-Waste Management \(Continued...\)](#)
- [Lecture 56 - E-Waste Management \(Continued...\)](#)
- [Lecture 57 - E-Waste Management \(Continued...\)](#)
- [Lecture 58 - E-Waste Management \(Continued...\)](#)
- [Lecture 59 - E-Waste Management \(Continued...\)](#)
- [Lecture 60 - E-Waste Management \(Continued...\)](#)
- [Lecture 61 - Tutorial - I](#)
- [Lecture 62 - Tutorial - II](#)

Lecture 1 - Introduction to Computational Hydraulics

Lecture 2 - Problem Definition and Governing Equations (GE)

Lecture 3 - Classification of Problems based on Initial Condition (IC) and/or Boundary Conditions (BC)

Lecture 4 - Classification of Differential Equations

Lecture 5 - Numerical Methods : Overview

Lecture 6 - Finite Difference Approximation

Lecture 7 - Ordinary Differential Equation : IVP

Lecture 8 - Ordinary Differential Equation : BVP

Lecture 9 - Partial Differential Equation : BVP

Lecture 10 - Partial Differential Equation : IBVP

Lecture 11 - Partial Differential Equation : Numerical Stability of IBVP

Lecture 12 - Partial Differential Equation : Numerical Stability of One Dimensional PDE

Lecture 13 - Finite Volume Method - Overview

Lecture 14 - Finite Volume Method - BVP

Lecture 15 - Finite Volume Method - IBVP

Lecture 16 - Finite Volume Method - Conservation Law

Lecture 17 - Upwind Approach

Lecture 18 - Godunov Approach

Lecture 19

Lecture 20

Lecture 21 - Mesh-Tree Method : Polynomial Interpolation Method

Lecture 22 - Mesh-Free Method : Moving Least Squares Method

Lecture 23 - Mesh-Free Method : Space-Time Moving Least Squares Method

Lecture 24 - Numerical Method : Matrix Structure and Scilab

Lecture 25 - Algebraic Equation : Gauss Elimination Method

Lecture 26 - Algebraic Equation : LU Decomposition Method

Lecture 27 - Algebraic Equation : Tri Diagonal Matrix Method

Lecture 28 - Algebraic Equation : Jacobis Method

Lecture 29 - Algebraic Equation : Gauss - Seidel Method

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**NPTEL : Finite Element Analysis (Civil Engineering)**

**Co-ordinators : Dr. B.N. Rao**

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**Co-ordinators : Dr. V. Thamizh Arasan**

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**Co-ordinators : Prof. M.S. Sivakumar**

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Lecture 5 - TM - Ring Test For Assessing The Quality of TMT/QST Steel Rebars

Lecture 6 - Corrosion of embedded metal; Types of reinforcement - Metallic and non metallic coated rebars

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

## NPTEL : NOC:Mechanical Characterization of Bituminous Materials (Civil Engineering)

Co-ordinators : Dr. J. Murali Krishnan, Prof. M. R. Nivitha, Prof. Neethu Roy, Prof. A. Padmarekha

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Lecture 6 - Characterisation of colloidal particles - II

Lecture 7 - Introduction to forces acting on an individual colloidal particle

Lecture 8 - Introduction to interaction between colloidal particles

Lecture 9 - Application of Brownian force: Measurement of diffusivity and size

Lecture 10 - Radiation used to study colloidal systems

Lecture 11 - Radiation used to study colloidal systems

Lecture 12 - Molecular origin of Van der waals forces

Lecture 13 - Vanderwaal interactions between particles

Lecture 14 - Problem on scaling of Vanderwaal interactions

Lecture 15 - Calculation of Vanderwaal's forces between semi-infinite blocks and Hamaker constant - I

Lecture 16 - Calculation of Vanderwaal's forces between semi-infinite blocks and Hamaker constant - II

Lecture 17 - Theories of Vanderwaal forces based on bulk properties and calculation of Hamaker constant using bulk properties

Lecture 18 - Effect of medium on Vanderwaal's interactions - I

Lecture 19 - Effect of medium on Vanderwaal's interactions - II

Lecture 20 - Colloid Polymer mixtures

Lecture 21 - Colloid polymer mixtures: colloid-solvent interactions and colloid-polymer interactions

Lecture 22 - Colloid polymer mixtures: Depletion flocculation

Lecture 23 - Colloid polymer mixtures: Depletion stabilisation

Lecture 24 - Depletion interactions

Lecture 25 - Steric interactions/osmotic repulsion

Lecture 26 - Tutorial problem on depletion interactions

Lecture 27 - Colloidal Interactions: Introduction to electrostatic interactions/electrical double layer interactions

Lecture 28 - Introduction to models of electrical double layer: Helmholtz model/capacitor model

Lecture 29 - Review and summary of Helmholtz model (or capacitor model) of electrical double layer

Lecture 30 - Models of electrical double layer: Diffuse double layer model/Gouy-Chapman model

Lecture 31 - Potential distribution near planar surfaces: Derivation of the Poisson-Boltzmann equation

[Lecture 32 - Potential distribution near planar surfaces: Solution to the linearised Poisson-Boltzmann equation](#)

[Lecture 33 - Potential distribution near spherical surfaces: Solution to linearised Poisson-Boltzmann equation](#)

[Lecture 34 - Comparison of Capacitor model and Diffuse double layer model](#)

[Lecture 35 - Models of electrical double layer: Gouy Chapman Theory - I](#)

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[Lecture 37 - Structure of Electrical double layer](#)

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[Lecture 39 - Potential Energy of repulsion between Planar double layers and DLVO Theory](#)

[Lecture 40 - Zeta Potential and Electrophoretic mobility of an ion](#)

[Lecture 41 - Electrokinetic Phenomena](#)

[Lecture 42 - Relation between Electrophoretic mobility and Zeta potential - I](#)

[Lecture 43 - Relation between Electrophoretic mobility and Zeta potential - II](#)

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[Lecture 45 - Characterization of Particles at interface](#)

[Lecture 46 - Experimental Observations -Concept of Electrostatic interactions and Stability at interfaces](#)

[Lecture 47 - Implications from Surface energy balances and Estimation of energy required for detachment](#)

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Lecture 2 - Polymers: Molecular structure

Lecture 3 - Process, structure, property

Lecture 4 - Biopolymers

Lecture 5 - Molecular weight and distribution

Lecture 6 - Polymerization

Lecture 7 - Macromolecular nature

Lecture 8 - Renewable sources for polymers

Lecture 9 - Polymerization/depolymerization

Lecture 10 - States of interest

Lecture 11 - Application based terms

Lecture 12 - Reuse and repurpose

Lecture 13 - Molecular conformations

Lecture 14 - Size, mobility and flexibility

Lecture 15 - Polyelectrolytes

Lecture 16 - Structures in biopolymers

Lecture 17 - Amorphous/crystalline states - 1

Lecture 18 - Amorphous/crystalline states - 2

Lecture 19 - Orientation

Lecture 20 - Interactions

Lecture 21 - Kinetics of crystallization

Lecture 22 - Glass transition - 1

Lecture 23 - Glass transition - 2

Lecture 24 - States in environment

Lecture 25 - Liquid crystalline polymers

Lecture 26 - Copolymers - 1

Lecture 27 - Copolymers - 2

Lecture 28 - Blends - 1

Lecture 29 - Blends - 2

Lecture 30 - Microstructure in polymers

Lecture 31 - Composites

Lecture 32 - Stress strain response

Lecture 33 - Additives for polymeric systems

Lecture 34 - Blends/composites in recycling

Lecture 35 - Physical/chemical crosslinking

Lecture 36 - Mechanical properties - I

Lecture 37 - Mechanical properties - II

Lecture 38 - Physical and chemical aging

Lecture 39 - Solutions: properties

Lecture 40 - Conducting polymers

Lecture 41 - Dielectric response - I

Lecture 42 - Dielectric response - II

Lecture 43 - Plasticity

Lecture 44 - Properties of composites

Lecture 45 - Viscoelasticity: introduction

Lecture 46 - Thermal response

Lecture 47 - Viscoelasticity: characterization

Lecture 48 - Viscoelasticity: simple models

Lecture 49 - Dynamic Mechanical analysis

Lecture 50 - Damping Applications

Lecture 51 - Time Temperature superposition

Lecture 52 - Impact and energy absorption

Lecture 53 - Testing for applications

Lecture 54 - Properties of blends

Lecture 55 - Biomimetic polymers

Lecture 56 - Advanced mechanics

Lecture 57 - Viscoelastic response: examples

Lecture 58 - Polymer packaging

Lecture 59 - Porous polymers/membranes

Lecture 60 - Polymer at interfaces

Lecture 61 - Diffusion in polymers

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Lecture 63 - Biopolymer applications

Lecture 64 - Adhesives and Paints

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[Lecture 66 - Polymerization kinetics](#)

[Lecture 67 - Polymerization reactors](#)

[Lecture 68 - Polymer processing - I](#)

[Lecture 69 - Polymer processing - II](#)

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[Lecture 81 - Absorption and leaching](#)

[Lecture 82 - Swelling of polymers](#)

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[Lecture 3 - Introduction to Construction Materials - Part 3](#)

[Lecture 4 - Materials Engineering Concepts - Part 1](#)

[Lecture 5 - Materials Engineering Concepts - Part 2](#)

[Lecture 6 - Materials Engineering Concepts - Part 3](#)

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[Lecture 8 - Materials Engineering Concepts - Part 5](#)

[Lecture 9 - Materials Engineering Concepts - Part 6](#)

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[Lecture 11 - Nature of Materials - Part 1](#)

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[Lecture 15 - Nature of Materials - Part 6](#)

[Lecture 16 - Nature of Materials - Part 6](#)

[Lecture 17 - Nature of Materials - Part 7](#)

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[Lecture 22 - Stone, Brick and Mortar 2 - Part 1](#)

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[Lecture 24 - Cement and Concrete 1 - Part 1](#)

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[Lecture 26 - Cement and Concrete 1 - Part 3](#)

[Lecture 27 - Cement and Concrete 2 - Part 1](#)

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[Lecture 29 - Cement and Concrete 3 - Part 1](#)

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[Lecture 31 - Cement and Concrete 4 - Part 1](#)

[Lecture 32 - Cement and Concrete 4 - Part 2](#)

[Lecture 33 - Metals - 1 - Part 1](#)

[Lecture 34 - Metals - 1 - Part 2](#)

[Lecture 35 - Metals - 2 - Part 1](#)

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[Lecture 37 - Metals - 3 - Part 1](#)

[Lecture 38 - Metals - 3 - Part 2](#)

[Lecture 39 - Metals - 4](#)

[Lecture 40 - Metals - 5 - Part 1](#)

[Lecture 41 - Metals - 5 - Part 2](#)

[Lecture 42 - Polymers and Composites - Part 1](#)

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[Lecture 44 - Polymers and Composites - Part 3](#)

[Lecture 45 - Pavement Materials 1 - Part 1](#)

[Lecture 46 - Pavement Materials 1 - Part 2](#)

[Lecture 47 - Pavement Materials 2 - Part 1](#)

[Lecture 48 - Pavement Materials 2 - Part 2](#)

[Lecture 49 - Wood and wood products - Part 1](#)

[Lecture 50 - Wood and wood products - Part 2](#)

[Lecture 51 - Glass](#)

## NPTEL : NOC:Introduction to Lean Construction (Civil Engineering)

Co-ordinators : Prof. Koshy Varghese, Prof. N Raghavan

- Lecture 1 - Course Contents, Long-term Goals, Structure and Module 1 Topics
- Lecture 2 - Pedagogy, Approach, Institutions, Instructors, Audience and Pre-requisites
- Lecture 3 - ILCE, Conferences, Resources, Further Work Possible
- Lecture 4 - Lean Implementation in India from ILCE Directors and other Talks/Testimonials
- Lecture 5 - Status of Lean Implementation in India through Industry Panel Discussion with ILCE Directors
- Lecture 6 - History of Lean and other Management Philosophies; Toyota Production System (TPS); What is Lean?
- Lecture 7 - Lean Construction Timeline; Lean Project Delivery vs LC; Project Management vs LC
- Lecture 8 - Key Lean Concepts#1 (Wastes)
- Lecture 9 - Key Lean Concepts#1 (Value, Value Stream, Flow, Pull, Perfection)
- Lecture 10 - Key Lean Concepts#2 (Continuous Improvement, Collaborative working, Production System, Lean Culture)
- Lecture 11 - Key Lean Tools#1 (Productivity Measurement System, Work Sampling, Value Stream Mapping)
- Lecture 12 - Lean Overview - Key Lean Tools#2 (5S, CPS/ LPS, Big Room Approach)
- Lecture 13 - Lean Overview - Future module
- Lecture 14 - Productivity Measurement and Improvement, Construction Productivity, Productivity levels
- Lecture 15 - What is Productivity, Production?; Illustration
- Lecture 16 - Productivity and Production Impact; Visualizing Activity Productivity and Production Performance
- Lecture 17 - Profit, ROCE, Influences on Operational Productivity; Operational view vs. System view, Summary
- Lecture 18 - Outline, Planning and monitoring levels; Productivity Measurement System
- Lecture 19 - Measuring Output - Level of Effort (LOE)
- Lecture 20 - Productivity and Production Calculations: daily, weekly, cumulative
- Lecture 21 - Productivity and Production Calculations: Performance Evaluation
- Lecture 22 - Productivity and Production Calculations: Workhour Forecast and Analysis of Trends
- Lecture 23 - Factors Influencing Productivity, Productivity Improvement Approach, Summary
- Lecture 24 - Sampling/ Surveying Techniques - Data Sources in Construction
- Lecture 25 - Construction Activity with Workers doing VA/ NVAN/ NVA; WS vs PMS; Work Sampling
- Lecture 26 - Sampling basics, Sampling in construction
- Lecture 27 - Steps to Conduct a Work Sampling Study; WS Outcomes
- Lecture 28 - Illustration of Tour-based Work Sampling Approach
- Lecture 29 - Illustration of Crew-based Work Sampling Approach
- Lecture 30 - Explore relationship between WS Categories and Productivity; Summary
- Lecture 31 - Sampling/ Surveying Techniques - Foreman delay survey

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- Lecture 32 - Sampling/ Surveying Techniques - Foreman delay survey - Implementation
- Lecture 33 - Foreman delay survey - Illustrations; Comparison - PMS vs WS vs FDS - discussion
- Lecture 34 - Value Stream, Value Stream Mapping (VSM), System vs Process, References
- Lecture 35 - Illustration: Value and Value Stream in Food Delivery
- Lecture 36 - Value, Value Stream, VSM/PM, Language, Basic VSM - current state and future state
- Lecture 37 - Key steps for VSM, Work: Degrees of Granularity, Measurement Metrics
- Lecture 38 - VSM - Example 1 (Reinforcement)
- Lecture 39 - VSM - Example 2 (Blockwork); Summary
- Lecture 40 - Flow Process Chart, Symbols, Process mapping - steps and timing, Measurement metrics
- Lecture 41 - Process mapping - Illustration: Reinforcement shifting
- Lecture 42 - VSM vs PM; Process Flow chart - variations; Swim-lane diagrams; Summary
- Lecture 43 - Understand the Basics of 5S, Explanations and 5S Steps
- Lecture 44 - Understand Each -S- in Detail - Sort, Set in Order, Shine
- Lecture 45 - Understand Each -S- in Detail - Standardize, Sustain
- Lecture 46 - 5S: Key Points, Benefits, Signs of a 5S Site
- Lecture 47 - Experiment 5S with Yourself First, Project Implementation, Facilitations, Why 5S May Fail?, Recap
- Lecture 48 - Understand the Applications of 5S through Case Studies\_2 cases
- Lecture 49 - Understand the Applications of 5S through Case Studies\_3 cases
- Lecture 50 - Understand the Applications of 5S through Case Study - Ms Diamond Barretto (Godrej Construction)
- Lecture 51 - Current Project Performance, Workflow Variation, Traditional PM vs Lean Production Management
- Lecture 52 - Some Key Lean Concepts, Focusing on frontline Execution, CPS - Collaborative Planning System
- Lecture 53 - CPS Process, Overall Schedules (Master Schedule,Phase Schedule,LAP, Weekly Plan),Constraint Analysis
- Lecture 54 - Collaborative -Pull- Planning, Percentage Plan Completed (PPC), Daily Huddle, Variance Analysis, RCA
- Lecture 55 - Lean Work Structuring
- Lecture 56 - Impact of PPC on Productivity, Key aspects,Advantages,The Necessary Conditions,Blocks - CPS,Summary
- Lecture 57 - COLPLASSE: Look-Ahead Plan, Constraint Analysis, Weekly Plan, Summary
- Lecture 58 - Lean Project Delivery System, Conclusion
- Lecture 59 - Understand the Applications of CPS/LPS through Case Studies
- Lecture 60 - CPS/LPS implementation in Construction Projects through a Panel of Experts - Part 1
- Lecture 61 - CPS/LPS implementation in Construction Projects through a Panel of Experts - Part 2
- Lecture 62 - CPS/LPS implementation in Construction Projects through a Panel of Experts - Part 3
- Lecture 63 - Introduction of Big Room Approach, Some Requirements for Efficient Working, Virtual BR Meetings
- Lecture 64 - Big Room Approach through Case Studies

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[Lecture 65 - Big Room Approach - Implementation case from URC Construction](#)

[Lecture 66 - Future Construction Site, Lean Tools and Processes, Automation strategies and impact, Programming](#)

[Lecture 67 - Document Management, Workflow Process, Communication/Collab./Authen., Sensing](#)

[Lecture 68 - Mechanisation/ Robots, Visualization, AI/ Analytics, BIM, CPS/ IOT/ Industry 4.0, Digital Twin](#)

[Lecture 69 - Challenges and Causes, Problem?, Lean, BIM?, Traditional vs BIM, Tools/Technology providers](#)

[Lecture 70 - BIM uses; Metrics](#)

[Lecture 71 - BIM and Lean, Implementation Framework, BIM Execution Plan, Evidence Cases, Key takeaway](#)

[Lecture 72 - How to Start Practicing Lean Tools in Project Sites-1: Work Sampling](#)

[Lecture 73 - How to Start Practicing Lean Tools in Project Sites-1: VSM](#)

[Lecture 74 - How to Start Practicing Lean Tools in Project Sites-1: 5S](#)

[Lecture 75 - How to Start Practicing Lean Tools in Project Sites-1: CPS/ LPS](#)

[Lecture 76 - How to Start Practicing Lean Tools in Project Sites-1: Big Room Approach](#)

[Lecture 77 - Acknowledgement](#)

Lecture 1 - Bolts: dimensions and material

Lecture 2 - Bolts: installation techniques and clearances

Lecture 3 - Design of Bearing type bolts in shear: Basic design principle

Lecture 4 - Correction factors for bolts for long joints, long grip lengths, and thick packing plate

Lecture 5 - Design of friction grip bolts in shear and design of bolts in tension

Lecture 6 - Structural Welding Process

Lecture 7 - Groove/Butt Welds

Lecture 8 - Fillet Welds - 1

Lecture 9 - Fillet Welds - 2

Lecture 10 - Weld symbols, defects, and filler material

Lecture 11 - Design of groove welds

Lecture 12 - Design of fillet welds - 1

Lecture 13 - Design of fillet welds - 2

Lecture 14 - Design example of a bolt group

Lecture 15 - Design example of a weld group

Lecture 16 - Simple and rigid frame connections

Lecture 17 - Design of double angle connections

Lecture 18 - Design of seated angle connections

Lecture 19 - End-plate rigid connection: Introduction

Lecture 20 - End-plate connection: Design example

Lecture 21 - Welded-flange rigid connection

Lecture 22 - Ductile detailed beam-column connections - 1

Lecture 23 - Ductile detailed beam-column connections - 2

- Lecture 1 - Pavement Cross-sections and Pavement Design Process
- Lecture 2 - Pavement Design Factors - I
- Lecture 3 - Pavement Design Factors - II
- Lecture 4 - Stresses and Strains in Bituminous Pavements - I
- Lecture 5 - Stresses and Strains in Bituminous Pavements - II
- Lecture 6 - Numerical Problems in One-layer Theory
- Lecture 7 - Numerical Problems in Two-layer Theory
- Lecture 8 - Introduction to KENLAYER
- Lecture 9 - KENLAYER - 1
- Lecture 10 - KENLAYER - 2
- Lecture 11 - KENLAYER - 3
- Lecture 12 - KENLAYER - 4
- Lecture 13 - Traffic Analysis - ESWL - Part 1
- Lecture 14 - Traffic Analysis - ESWL - Part 2
- Lecture 15 - Traffic Analysis - EALF
- Lecture 16 - Traffic Analysis - ESAL using VDF
- Lecture 17 - Traffic Analysis - ESAL using TF
- Lecture 18 - Traffic Analysis - Examples
- Lecture 19 - Traffic Analysis - Load Spectra Factor
- Lecture 20 - Modulus for Design - CBR
- Lecture 21 - Modulus for Design - Resilient modulus (Granular material)
- Lecture 22 - Modulus for Design - Resilient modulus (Bituminous material)
- Lecture 23 - Modulus for Design - Dynamic Modulus
- Lecture 24 - Environmental Effect - Part 1
- Lecture 25 - Environmental Effect - Part 2
- Lecture 26 - Environmental Effect - Part 3
- Lecture 27 - Environmental Effect - Part 4
- Lecture 28 - Enhanced Integrated Climatic Model - Part 1
- Lecture 29 - Enhanced Integrated Climatic Model - Part 2
- Lecture 30 - Climate Consideration in Design Procedures
- Lecture 31 - Reliability in Pavement Design - Part 1

- Lecture 32 - Reliability in Pavement Design - Part 2
- Lecture 33 - Reliability in Pavement Design - Part 3
- Lecture 34 - Reliability in Pavement Design - Part 4
- Lecture 35 - Reliability in Pavement Design - Part 5
- Lecture 36 - Reliability in Pavement Design - Part 6
- Lecture 37 - Distress Transfer Function - Fatigue Cracking
- Lecture 38 - Rutting and Low-Temperature Cracking
- Lecture 39 - KENLAYER - Nonlinear Analysis
- Lecture 40 - KENLAYER - Damage Analysis
- Lecture 41 - IRC design steps
- Lecture 42 - Design Input and IITPAVE software
- Lecture 43 - Pavement design with granular base
- Lecture 44 - Pavement design with CTB
- Lecture 45 - Pavement design with RAP Base
- Lecture 46 - Overview of Mechanistic-Empirical Pavement Design Methods - IRC
- Lecture 47 - Overview of Mechanistic-Empirical Pavement Design Methods - South Africa - Part I
- Lecture 48 - Overview of Mechanistic-Empirical Pavement Design Methods - South Africa - Part II
- Lecture 49 - Overview of Mechanistic-Empirical Pavement Design Methods - South Africa - Part III
- Lecture 50 - Overview of Mechanistic-Empirical Pavement Design Methods - Australia - Part I
- Lecture 51 - Overview of Mechanistic-Empirical Pavement Design Methods - Australia - Part II
- Lecture 52 - Overview of Mechanistic-Empirical Pavement Design Methods - AASHTO - Part I
- Lecture 53 - Overview of Mechanistic-Empirical Pavement Design Methods - AASHTO - Part II
- Lecture 54 - Summary of the course and design projects



Lecture 1 - Introductory lecture and course outline

Lecture 2 - Matrix algebra and Gauss elimination method

Lecture 3 - Development of equilibrium equations for 1-d systems

Lecture 4 - Development of equilibrium equations for 2-d bar elements and truss structures

Lecture 5 - Development of equilibrium equations for beam elements

Lecture 6 - Virtual work and principle of stationary potential energy

Lecture 7 - Introduction to Rayleigh-Ritz Method

Lecture 8 - Use of GEOFEM finite element program - Part I

Lecture 9 - Use of GEOFEM finite element program - Part II

Lecture 10 - Stresses and strains in continuum

Lecture 11 - 2-dimensional approximations of continuum

Lecture 12 - Analysis of continuum systems

Lecture 13 - 3-node Constant Strain Triangle

Lecture 14 - Classical methods for developing shape functions

Lecture 15 - Numerical integration techniques

Lecture 16 - Isoparametric Elements - Part I

Lecture 17 - Isoparametric Elements - Part II

Lecture 18 - Isoparametric calculations for stiffness and load vectors

Lecture 19 - Force vector due to surface traction

Lecture 20 - Patch test and Finite Element Modelling

Lecture 21 - GEOFEM - Part III

Lecture 22 - In situ earth pressures, construction and excavation sequences

Lecture 23 - Joint and interface element modelling

Lecture 24 - Modelling of interfaces - Joint Elements

Lecture 25 - Mapped infinite elements for semi-infinite soil medium

Lecture 26 - Some observations of soil behaviour and stress invariants

Lecture 27 - Nonlinear analysis technique - 1

Lecture 28 - Nonlinear analysis technique - 2

Lecture 29 - Nonlinear analysis technique - 3

Lecture 30 - Bilinear elastic models

Lecture 31 - Nonlinear elastic and hyperbolic models

[Lecture 32 - Modified hyperbolic model and determination of material parameters](#)

[Lecture 33 - Stress correction procedures in finite element analysis](#)

[Lecture 34 - Numerical examples on working with modified hyperbolic models](#)

[Lecture 35 - Some Limit solutions in geotechnical engineering](#)

[Lecture 36 - Elastic - Plastic Constitutive Matrix](#)

[Lecture 37 - Nonassociated Elastic - Plastic Joint Element](#)

[Lecture 38 - Introduction to consolidation and dynamic analysis](#)

[Lecture 39 - Cam Clay models](#)

[Lecture 40 - Modified cam clay models](#)

[Lecture 41 - FEM in Geotechnical applications](#)

[Lecture 42 - Soil behaviour and An Introduction to the Existing Soil Models](#)

[Lecture 43 - Simulation of soil liquefaction using FLAC](#)

[Lecture 44 - Mitigation of soil liquefaction using granular columns](#)

Lecture 1 - Course Structure

Lecture 2 - Introduction to Google Earth

Lecture 3 - How Does Earth Science Work ?

Lecture 4 - What is a Mineral

Lecture 5 - Minerals and Rock Cycle

Lecture 6 - Continental Drift

Lecture 7 - Plate Tectonics

Lecture 8 - What are Igneous Rocks ?

Lecture 9 - Compositional Variation of Igneous Rocks

Lecture 10 - Why Does the Rock Melt ?

Lecture 11 - Igneous Activity and Plate Tectonics

Lecture 12 - Igneous Structures

Lecture 13 - Volcanoes

Lecture 14 - Discussion on Posted Questions

Lecture 15 - What are Metamorphic Rocks

Lecture 16 - Types of Metamorphism

Lecture 17 - Metamorphism and Plate Tectonics

Lecture 18 - Weathering and Erosion

Lecture 19 - Detrital Sedimentary Rocks

Lecture 20 - Chemical and Organic Sedimentary Rocks

Lecture 21 - Sedimentary Environment and Plate Tectonics

Lecture 22 - Discussion on Conceptual Questions

Lecture 23 - Discussion on Posted Questions

Lecture 24 - Diversity of Life

Lecture 25 - Why Do Groups Change ?

Lecture 26 - Nature of Paleontological Data

Lecture 27 - Introduction to PaleoDB

Lecture 28 - Relative Age

Lecture 29 - Correlation

Lecture 30 - Attempts to Estimate Absolute Age

Lecture 31 - Radiometric Dating

Lecture 32 - Rocks Full of Life

Lecture 33 - Discussion on Posted Questions\_3

Lecture 34 - The Beginning

Lecture 35 - The Formation of the Planets and Moon

Lecture 36 - The Formation of the Continents

Lecture 37 - The Formation of the Atmosphere and Ocean

Lecture 38 - Origin of Life: Initial Ideas

Lecture 39 - Origin of Life: Which Biomolecules Came First ?

Lecture 40 - Origin of Life: Where did it all Start ?

Lecture 41 - Evidence of Early Life

Lecture 42 - Proterozoic Events and Life

Lecture 43 - Discussion on Posted Questions\_4

Lecture 44 - Cambrian Earth and Life

Lecture 45 - Cambrian Explosion

Lecture 46 - Journey to Land: Fishes and Tetrapods

Lecture 47 - Journey to Land: Transitional Forms

Lecture 48 - Appearance of Amniotes

Lecture 49 - Dinosaurs

Lecture 50 - Dinosaurs Footprints

Lecture 51 - Appearance of Feathers

Lecture 52 - Mass Extinctions and Their Impact

Lecture 53 - K-Pg Extinction: Patterns

Lecture 54 - K-Pg Extinction: Mechanisms

Lecture 55 - Paleoclimatic Reconstruction

Lecture 56 - Cenozoic Climate

Lecture 57 - Recovery from K-Pg: Paleogene Event

Lecture 58 - Who are Whales ?

Lecture 59 - Discussion on Posted Questions\_5

Lecture 60 - Development of Bipedality

Lecture 61 - Early Hominids

Lecture 62 - Megafaunal Extinction

Lecture 63 - Recent Extinctions

Lecture 64 - Anthropocene and Future



Lecture 1 - Introduction-Overview of RCC - Part 1

Lecture 2 - Introduction-Overview of RCC - Part 2

Lecture 3 - Introduction to Design Concepts and Philosophies - Part 1

Lecture 4 - Introduction to Design Concepts and Philosophies - Part 2

Lecture 5 - Materials Short Term Properties - Part 1

Lecture 6 - Materials Short Term Properties - Part 2

Lecture 7 - Materials Short Term Properties - Part 3

Lecture 8 - Materials Short Term Properties - Part 4

Lecture 9 - Materials Long Term Properties - Part 1

Lecture 10 - Materials Long Term Properties - Part 2

Lecture 11 - Materials Rebar Properties

Lecture 12 - Durability - Overview

Lecture 13 - Durability - Effect of Chemical actions

Lecture 14 - Durability - Effect of Physical,mechanical and corrosion

Lecture 15 - Durability - Design approaches and code provisions

Lecture 16 - Axial Behaviour - Introduction

Lecture 17 - Axial Behaviour of Reinforced Concrete

Lecture 18 - Axial Behaviour - Effect of Compressive Strength

Lecture 19 - Flexure Behaviour - Background to flexural theory

Lecture 20 - Flexure Behaviour - Moment curvature analysis-procedure

Lecture 21 - Flexure Behaviour - Example-Moment curvature of singly reinforced section

Lecture 22 - Flexure Behaviour - Effect of increasing reinforcement on Moment curvature behaviour

Lecture 23 - Flexure Behaviour - Effect of compressive strength on Moment curvature, behaviour

Lecture 24 - Flexure Behaviour - Effect of axial Compression on Moment curvature behaviour - Part 1

Lecture 25 - Flexure Behaviour - Effect of axial Compression on Moment curvature behaviour - Part 2

Lecture 26 - Flexure Behaviour - Effect of Compression steel on Moment curvature behaviour - Part 1

Lecture 27 - Flexure Behaviour - Effect of Compression steel on Moment curvature behaviour - Part 2

Lecture 28 - Flexure Behaviour - Analysis and Design of Singly Reinforced Sections using IS Code - Part 1

Lecture 29 - Flexure Behaviour - Analysis and Design of Singly Reinforced Sections using IS Code - Part 2

Lecture 30 - Flexure Behaviour - Examples in Flexure using IS Code Provisions

Lecture 31 - Flexure Behaviour - Analysis and Design of Doubly Reinforced Sections using IS Code

Lecture 32 - Flexure Behaviour - Analysis and Design of Flanged Sections using IS $\tilde{A}$ , Code $\tilde{A}$ , Provisions

Lecture 33 - Shear Behaviour of RC elements - Part 1

Lecture 34 - Shear Behaviour of RC elements - Part 2

Lecture 35 - Shear Behaviour of RC elements - Part 3

Lecture 36 - Shear Behaviour - Shear Design using IS 456 Provisions

Lecture 37 - Shear Behaviour - Examples for Shear Design using IS 456 Provisions

Lecture 38 - Shear Behaviour - Torsional Behaviour of RC elements - Part 1

Lecture 39 - Shear Behaviour - Torsional Behaviour of RC elements - Part 2

Lecture 40 - Shear Behaviour - Torsional Behaviour of RC elements - Part 3

Lecture 41 - Shear Behaviour - Torsion Design of RC Beams using IS 456 Provisions

Lecture 42 - Compression behaviour of RC Columns - Intro and Types - Part 1

Lecture 43 - Compression behaviour of RC Columns - Short vs Slender and Effective length - Part 2

Lecture 44 - Compression behaviour of RC Columns - Lateral Flexibility and Example - Part 3

Lecture 45 - Compression behaviour of RC Columns IS Code Provisions - Part 1

Lecture 46 - Compression behaviour of RC Columns Confinement and Tied Vs Spiral Confined Columns - Part 2

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Lecture 57 - Special concretes - High strength concrete - Stress:strain relationships, applications

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Lecture 59 - Special concretes: Self compacting concrete -Introduction, design requirements and plastic shrinkage

Lecture 60 - Special concretes: Self compacting concrete - Segregation and laboratory tests

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- Lecture 3 - An overview of recycled concrete aggregates (RCA): sources and types - Part 1
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- Lecture 12 - Effect of moisture condition on the microstructure and design of RCA concrete - Part 1
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- Lecture 17 - Environmental impact and life cycle assessment (LCA) - Part 1
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- Lecture 21 - Recycled concrete aggregates market: problems and prospects - Part 1
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Lecture 3 - Climatic Variables of the Atmosphere

Lecture 4 - Atmospheric Layers; Troposphere; Temperature Lapse Rate

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Lecture 6 - Atmospheric Gas Concentration and introduction to Atmospheric Pressure

Lecture 7 - Atmospheric Pressure and Mass

Lecture 8 - How to Measure Vertical Variation of Pressure

Lecture 9 - Fundamentals of Atmospheric Humidity and Weather Variables

Lecture 10 - Advanced Atmospheric Humidity Concepts Contours and Key Relationships

Lecture 11 - Virtual Temperature and Atmospheric Stability Concepts

Lecture 12 - Understanding Atmospheric Stability Adiabatic Relations and Lapse Rate

Lecture 13 - Potential Temperature, Adiabatic Lapse Rate of Moist Air, Three Possible Stability Relationships

Lecture 14 - Derivation of Potential Temperature, Deriving the Expression for Saturated Adiabatic Lapse Rate

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Lecture 16 - Temperature Gradient of Dry and Saturated Air Parcel, Earth Sun Relationship

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Lecture 18 - Understanding Earth'S Seasons Axial Tilt, Solstice, and Equinox Dynamics

Lecture 19 - Mean Emission Temperature of Earth and the Greenhouse Effect - Part 1

Lecture 20 - Mean Emission Temperature of Earth and the Greenhouse Effect - Part 2

Lecture 21 - Mean Emission Temperature of Earth and the Greenhouse Effect - Part 3

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Lecture 23 - Derivation of Beam Spreading Effect, Derivation of the Greenhouse Effect

Lecture 24 - Derivation of Analysing the Atmosphere of Venus, Radiation Fluxes

Lecture 25 - Principles of Electromagnetic Radiation Spectral Intensity, Irradiance, and Material Interactions

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Lecture 27 - Atmospheric Absorption and Radiative Transfer

Lecture 28 - Radiative Transfer in the Atmosphere Key Concepts

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- Lecture 2 - Sources of indoor air pollutants - 1
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- Lecture 5 - Methods to estimate emissions
- Lecture 6 - Mass balance
- Lecture 7 - Mass balance Simple Examples
- Lecture 8 - Residence times and Fractional losses
- Lecture 9 - Multi-room (multi-box) models
- Lecture 10 - Examples
- Lecture 11 - Outdoor air as source to indoor air. Introduction
- Lecture 12 - Outdoor air as source to indoor air. Infiltration, health
- Lecture 13 - Indoor-Outdoor relationship
- Lecture 14 - Air exchange and ventilation rates
- Lecture 15 - Health-based ventilation framework
- Lecture 16 - Aerosol Basics
- Lecture 17 - Aerosol Deposition
- Lecture 18 - Coagulation, condensation and evaporation processes
- Lecture 19 - Aerosol sources and aerosol properties
- Lecture 20 - Indoor air chemistry: basics of chemical kinetics
- Lecture 21 - Indoor air chemistry: some key reactions
- Lecture 22 - Surface reactions
- Lecture 23 - Examples
- Lecture 24 - Bioaerosols in the Indoor Atmosphere: Introduction
- Lecture 25 - Bioaerosols in the Indoor Atmosphere: Sources
- Lecture 26 - Indoor bioaerosols and health impacts
- Lecture 27 - Environmental factors and bioaerosols
- Lecture 28 - Indoor air exposure risk assessment - principles
- Lecture 29 - Calculation of daily dose
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Lecture 1 - Geographic Information System An Introduction

Lecture 2 - Introduction to Global Positioning System

Lecture 3 - GPS Positioning Methods

Lecture 4 - GPS Solutions and Errors

Lecture 5 - GPS Application

Lecture 6 - Remote Sensing Introduction

Lecture 7 - Electromagnetic Spectrum

Lecture 8 - Sensors and Platform

Lecture 9 - Sensors and Platform

Lecture 10 - Image Interpretation

Lecture 11 - Statistical Evaluation of RS Data

Lecture 12 - Rectification and Restoration

Lecture 13 - Image Enhancement

Lecture 14 - Image Transformation

Lecture 15 - Orthogonal Transformation

Lecture 16 - Image Classification (Supervised Classification)

Lecture 17 - Image Classification (Unsupervised Classification)

Lecture 18 - Spatial Filtering-Noise Removal

Lecture 19 - Spatial Filtering-Edge Removal

Lecture 20 - Photogramatic-Basic concepts of a single photography

Lecture 21 - Stereoscopy-Basic concepts

Lecture 22 - Stereoscopy-Geometry of overlaping photograph

Lecture 23 - Terrestrial Photogrammetry

Lecture 24 - Digital Elevation Model-Basic Concepts

Lecture 25 - Digital Elevation Model-Data Input and Stamping

Lecture 26 - Digital Elevation Model-Surface representation and analysis

Lecture 27 - GIS-Introductory Concepts

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[Lecture 37 - Zonal based tourism planning](#)

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**NPTEL : Transportation Engineering II (Civil Engineering)**

**Co-ordinators : Prof. Rajat Rastogi**

Lecture 1 - Introduction to Railway Engineering

Lecture 2 - Gauges and Permanent Way

Lecture 3 - Wheel and Axles, Coning of Wheels

Lecture 4 - Track Resistances, Hauling Capacity

Lecture 5 - Track Modulus, Stresses in Track

Lecture 6 - Stresses in Components of Track

Lecture 7 - Rails

Lecture 8 - Creep in Rails

Lecture 9 - Wears & Failures in Rails

Lecture 10 - Jointed or Welded rails

Lecture 11 - Sleepers

Lecture 12 - Ballast

Lecture 13 - Fastenings

Lecture 14 - Geometric Design - Alignment of Track

Lecture 15 - Horizontal Curve and Super elevation

Lecture 16 - Speeds on Track

Lecture 17 - Transition Curve & Widening of Track

Lecture 18 - Vertical Curve & Gradients

Lecture 19 - Turnouts - Components

Lecture 20 - Crossing and Design of Turnout

Lecture 21 - Track Junctions and Designs

Lecture 22 - Signals - Part 1

Lecture 23 - Signals - Part 2

Lecture 24 - Train Control Systems

Lecture 25 - Interlocking of Track

Lecture 26 - High Speed Tracks

Lecture 27 - Introduction of Air Transport

Lecture 28 - Aircraft Characteristics

Lecture 29 - Aircraft Controls, Airport Site&Size Selection

Lecture 30 - Airport Obstructions

Lecture 31 - Runway Orientation

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[Lecture 34 - Taxiway](#)

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[Lecture 36 - Aprons and Aircraft Parking](#)

[Lecture 37 - Terminal Area and Building](#)

[Lecture 38 - Terminal Planning and Hangers](#)

[Lecture 39 - Visual Aids-Markings](#)

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- Lecture 1 - What is Geographic Information Systems ?
- Lecture 2 - Different components of GIS
- Lecture 3 - Different types of vector data and concept of topology
- Lecture 4 - Raster data models and comparisons with vector
- Lecture 5 - TIN data model and comparisons with raster
- Lecture 6 - Non-spatial data (attributes) and their type
- Lecture 7 - Raster data compression techniques
- Lecture 8 - Spatial database systems and their types
- Lecture 9 - Pre-processing of spatial datasets
- Lecture 10 - Geo-referencing
- Lecture 11 - Different map projections
- Lecture 12 - Spatial interpolation techniques
- Lecture 13 - Digital Elevation Models and different types of resolutions
- Lecture 14 - Quality assessment of freely available DEMS
- Lecture 15 - GIS analysis - Part 1
- Lecture 16 - GIS analysis - Part 2 (Overlaying Operations)
- Lecture 17 - GIS analysis - Part 3 (Buffer Analysis)
- Lecture 18 - Classification Methods
- Lecture 19 - Errors in GIS and Key elements of maps
- Lecture 20 - Limitations of GIS



Lecture 1 - Solar Geometry

Lecture 2 - Climate Classification

Lecture 3 - Thermal Comfort in Built Environment - 1

Lecture 4 - Thermal Comfort in Built Environment - 2

Lecture 5 - Thermal Adaptation

Lecture 6 - Bioclimatic Assessment

Lecture 7 - Thermal Performance of Building Envelop

Lecture 8 - Thermal Performance of Building Envelop - Indices and Measures (1/2)

Lecture 9 - Thermal Performance of Building Envelop - Indices and Measures (2/2)

Lecture 10 - Glazing and Shading Systems

Lecture 11 - Shading Analysis

Lecture 12 - Energy Efficiency and Simulation

Lecture 13 - Building Acoustics - Basics

Lecture 14 - Sound Propagation

Lecture 15 - Acoustic Quality Indicators (1/2)

Lecture 16 - Acoustic Quality Indicators (2/2)

Lecture 17 - Acoustic Design Considerations

Lecture 18 - Acoustic Materials

Lecture 19 - Lighting - Basics

Lecture 20 - Lighting – Design Concepts

Lecture 1 - Introduction (GPS Surveying and Applications)

Lecture 2 - GPS System

Lecture 3 - GPS Signal (Civilian Perspective)

Lecture 4 - GPS Receiver

Lecture 5 - GPS Software

Lecture 6 - GPS Position

Lecture 7 - GPS Positioning (Principle and Methods)

Lecture 8 - Field demonstration of GPS Positioning Method

Lecture 9 - GPS Observables (Types, Errors and Quality)

Lecture 10 - Errors in GPS Observables (Systematics Errors)

Lecture 11 - GPS Data Pre-Processing - I

Lecture 12 - GPS Data Pre-Processing - II

Lecture 13 - GPS Data Processing - I

Lecture 14 - GPS Data Processing - II

Lecture 15 - Quality Assessment of GPS Surveying

Lecture 16 - Procedure of GPS Surveying - I

Lecture 17 - Procedure of GPS Surveying - II

Lecture 18 - Procedure of GPS Surveying - III

Lecture 19 - GPS Field Surveying

Lecture 20 - GPS Data Processing

Lecture 1 - Introduction and Applications

Lecture 2 - Fundamentals and Operations

Lecture 3 - Overview of Digital Land Surveying

Lecture 4 - Introduction of GPS

Lecture 5 - GPS Signal (Civilian Perspective)

Lecture 6 - GPS User Segment

Lecture 7 - GPS Positioning of Control Point

Lecture 8 - Demonstration of GPS Receivers, Software and Positioning of Control Point

Lecture 9 - GPS Position

Lecture 10 - Principle of GPS Positioning and GPS Observables

Lecture 11 - Errors in GPS Observables

Lecture 12 - GPS Data Pre-processing: Differencing

Lecture 13 - GPS Data Pre-processing: Point Positioning

Lecture 14 - GPS Data Processing: Baseline Processing

Lecture 15 - GPS Data Processing: Network Adjustment

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Lecture 17 - Introduction to Total Station

Lecture 18 - Parts of Total Station

Lecture 19 - Accessories of Total Station

Lecture 20 - Handling and Setting of Total Station

Lecture 21 - Measurement of Distance

Lecture 22 - Measurement of Distance Using TS

Lecture 23 - Measurement of Horizontal Angle Using TS

Lecture 24 - Measurement of Vertical Angle and Height Using TS

Lecture 25 - Errors in Total Station

Lecture 26 - Other Errors in Total Station

Lecture 27 - Errors and Quality of Surveying Measurements

Lecture 28 - Error Propagation and Survey Specifications

Lecture 29 - Basics of Vertical Representation

Lecture 30 - Contouring

Lecture 31 - Mapping Fundamentals

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Lecture 2 - Different Techniques of Image Acquisition

Lecture 3 - Why is Digital Image processing Important ?

Lecture 4 - Image characteristics and Different Resolutions in Remote Sensing

Lecture 5 - Electromagnetic spectrum, solar reflection, and thermal emission

Lecture 6 - Color Representation and Transformations

Lecture 7 - Image histograms and statistics

Lecture 8 - Geo-referencing Techniques

Lecture 9 - Image Enhancement Techniques part 1

Lecture 10 - Image Enhancement Techniques part 2

Lecture 11 - Multispectral Transform, Scatter Plot, Principal Component Analysis and Decorrelation Stretch

Lecture 12 - Spatial Filtering Techniques

Lecture 13 - Frequency Domain Fourier Transformation

Lecture 14 - Basic Image Compression Techniques and Different Image File Formats

Lecture 15 - Image Classification Techniques

Lecture 16 - Principles of Image Interpretation

Lecture 17 - SAR Interferometry (InSAR) Techniques

Lecture 18 - Image Merging and Image Mosaicing Techniques

Lecture 19 - Application of Image Analysis

Lecture 20 - Limitations and Future of Digital Image Processing

Lecture 1 - Introduction - I

Lecture 2 - Introduction - II

Lecture 3 - Cell Structure - I

Lecture 4 - Cell Structure - II

Lecture 5 - Central Dogma - I

Lecture 6 - Central Dogma - II

Lecture 7 - Microbial Energetics - I

Lecture 8 - Microbial Energetics - II

Lecture 9 - Microbial Energetics - III

Lecture 10 - Microbial Energetics - IV

Lecture 11 - Microbial Metabolism - I

Lecture 12 - Microbial Metabolism - II

Lecture 13 - Functional Diversity of Bacteria - I

Lecture 14 - Functional Diversity of Bacteria - II

Lecture 15 - Functional Diversity of Bacteria - III

Lecture 16 - Microbial Ecosystem - I

Lecture 17 - Microbial Ecosystem - II

Lecture 18 - Microbial Ecosystem - III

Lecture 19 - Microbial Ecosystem - IV

Lecture 20 - Microbial Ecosystem - V

Lecture 21 - Environmental Genomics - I

Lecture 22 - Environmental Genomics - II

Lecture 23 - Environmental Genomics - III

Lecture 24 - Environmental Genomics - IV

Lecture 25 - Environmental Genomics - V

Lecture 26 - Microbial Symbiosis - I

Lecture 27 - Microbial Symbiosis - II

Lecture 28 - Virus - I

Lecture 29 - Virus - II

Lecture 30 - Applied Environmental Microbiology

Lecture 31 - Techniques in Environmental Microbiology - I

[Lecture 32 - Techniques in Environmental Microbiology - II](#)

[Lecture 33 - Bioremediation - I](#)

[Lecture 34 - Bioremediation - II](#)

[Lecture 35 - Bioremediation - III](#)

[Lecture 36 - Wastewater Microbiology - I](#)

[Lecture 37 - Wastewater Microbiology - II](#)

[Lecture 38 - Built Microbiology](#)

[Lecture 39 - Exposomes - I](#)

[Lecture 40 - Exposomes - II](#)

[Lecture 41 - Drinking Water Microbiology - I](#)

[Lecture 42 - Drinking Water Microbiology - II](#)

[Lecture 43 - Drinking Water Microbiology - III](#)

[Lecture 44 - Drinking Water Microbiology - IV](#)

[Lecture 45 - Drinking Water Microbiology - V](#)

[Lecture 46 - Solid Waste Microbiology - I](#)

[Lecture 47 - Solid Waste Microbiology - II](#)

[Lecture 48 - Solid Waste Microbiology - III](#)

[Lecture 49 - Antimicrobial Resistance - I](#)

[Lecture 50 - Antimicrobial Resistance - II](#)

[Lecture 51 - Epidemiology - I](#)

[Lecture 52 - Epidemiology - II](#)

[Lecture 53 - Biosensors - I](#)

[Lecture 54 - Biosensors - II](#)

[Lecture 55 - Biosensors - III](#)

[Lecture 56 - Bioinformatics - I](#)

[Lecture 57 - Bioinformatics - II](#)

[Lecture 58 - Bioinformatics - III](#)

[Lecture 59 - Bioinformatics - IV](#)

[Lecture 60 - Bioinformatics - V](#)

- Lecture 1 - Concept of Digital Elevation Model and How It Is Represented
- Lecture 2 - Various Techniques to Generate Digital Elevation Model - 1
- Lecture 3 - Various Techniques to Generate Digital Elevation Model - 2
- Lecture 4 - Various Techniques to Generate Digital Elevation Model - 3
- Lecture 5 - Importance of Spatial Resolution With DEMs
- Lecture 6 - How To Assess Quality of DEM?
- Lecture 7 - Integration of DEMs With Satellite Data
- Lecture 8 - Common Derivatives of DEMs- Slope and Aspect
- Lecture 9 - Triangulated Irregular Network (TIN) and Its Derivatives
- Lecture 10 - Shaded Relief Models and Their Applications
- Lecture 11 - DEMs Derivatives - 1
- Lecture 12 - DEMs Derivatives - 2
- Lecture 13 - DEMs Derivatives - 3
- Lecture 14 - DEMs Derivatives - 4
- Lecture 15 - DEM Based Surface Hydrologic Modelling - 1
- Lecture 16 - DEM Based Surface Hydrologic Modelling - 2
- Lecture 17 - DEM and DAM Simulation and Its Application In Ground Water Hydrology
- Lecture 18 - Applications of DEMs In Solar and Wind Energy Potential Estimations
- Lecture 19 - Applications of DEMs in Viewshed and Flood Hazard Mapping
- Lecture 20 - DEMs Sources, Limitations and Future of Digital Elevation Models



- Lecture 1 - Introduction, Fundamentals of Equilibrium and Kinetics
- Lecture 2 - Equilibrium-Process Feasibility, Gibbs Energy-Standard Condition
- Lecture 3 - Gibbs Free Energy-Non Standard Conditions - I
- Lecture 4 - Gibbs Free Energy-Non Standard Conditions - II
- Lecture 5 - Phase Equilibrium
- Lecture 6 - Component Balance
- Lecture 7 - Reaction Kinetics
- Lecture 8 - Rate of Reaction - I
- Lecture 9 - Rate of Reaction - II, Types of Reactors
- Lecture 10 - Mass Balance on different types of Reactors
- Lecture 11 - Material Balance for Complex Reactions
- Lecture 12 - Material Balance for Reversible Reactions
- Lecture 13 - Determination of Kinetic Equations
- Lecture 14 - Acid-Base Reactions
- Lecture 15 - Acid Dissociation Constant, Strength of Acid
- Lecture 16 - Ionization Fractions
- Lecture 17 - Introduction to VMINTEQ
- Lecture 18 - Estimation of pH using VMINTEQ
- Lecture 19 - Mixing Problems
- Lecture 20 - Inverse Dose Problems
- Lecture 21 - logC-pH Diagram
- Lecture 22 - Carbonate System: Closed System
- Lecture 23 - Carbonate System: Open System
- Lecture 24 - VMINTEQ: Application of Gases, Acid-Base Titration
- Lecture 25 - VMINTEQ: Titration and Multisweep, Buffer: Introduction
- Lecture 26 - VMINTEQ: Buffer System, Buffer Intensity: Introduction
- Lecture 27 - Buffer Intensity: Monoprotic and Diprotic Acids
- Lecture 28 - Alkalinity: Introduction
- Lecture 29 - Alkalinity: Theoretical and Practical Definition
- Lecture 30 - Acidity and its Applications
- Lecture 31 - Alkalinity and Acidity: Applications

- Lecture 32 - Mixing of Two Solutions and Conservative Quantities - I
- Lecture 33 - Mixing of Two Solutions and Conservative Quantities - II
- Lecture 34 - Carbonate and Non-Carbonate Alkalinity
- Lecture 35 - Anaerobic Digester: Acid Formation and Neutralization
- Lecture 36 - Aqueous Complexes: Applications in Toxicity Reduction
- Lecture 37 - Aqueous Complexes: Solubility, Rate Constants and Strength of Ligands
- Lecture 38 - Aqueous Complexes of Aluminium (Al)
- Lecture 39 - Aqueous Complexes of Mercury (Hg)
- Lecture 40 - Precipitation and Dissolution: Introduction and Applications
- Lecture 41 - Applications of Precipitation and Dissolution
- Lecture 42 - Different Stages in Precipitation, Equilibrium of Precipitation - I
- Lecture 43 - Equilibrium of Precipitation - II
- Lecture 44 - Examples Related to Equilibrium of Precipitation
- Lecture 45 - Other Examples of Equilibrium of Precipitation
- Lecture 46 - Solubility and Competitive Precipitation
- Lecture 47 - Predominance Area Diagram and Introduction to Redox Processes
- Lecture 48 - Redox Reactions and its Applications
- Lecture 49 - Balancing of Redox and Development of Half Reaction
- Lecture 50 - Kinetics of Redox Processes
- Lecture 51 - Equilibrium of Redox - I
- Lecture 52 - Equilibrium of Redox - II and Reaction Feasibility
- Lecture 53 - Reaction Feasibility Based on  $P_e$  - I
- Lecture 54 - Reaction Feasibility Based on  $P_e$  - II
- Lecture 55 - Effect of Complexation on Redox
- Lecture 56 - Effect of Complexation and Solid Phase on Redox
- Lecture 57 - Reaction Feasibility based on  $E_h$
- Lecture 58 - Introduction to Electrochemical cell (Ecell)
- Lecture 59 - Applications of Ecell
- Lecture 60 -  $\log C$ - $P_e$  and  $pH$ - $P_e$  Diagram

Lecture 1 - Introduction - I

Lecture 2 - Introduction - II

Lecture 3 - Course Outline

Lecture 4 - Introduction to hazardous waste laws and risk assessment

Lecture 5 - The major aspects of Risk Assessment

Lecture 6 - Risk Characterization

Lecture 7 - Risk Assessment - Deterministic approach

Lecture 8 - Risk Assessment - Stochastic Approach

Lecture 9 - Hazardous Waste laws - The TCLP Test

Lecture 10 - Hazardous rules and regulations

Lecture 11 - Remediation of contaminated GW-Plume Containment

Lecture 12 - Remediation of contaminated GW-Javandel et al's approach

Lecture 13 - Remediation of contaminated GW by Pump and Treat - I

Lecture 14 - Remediation of contaminated GW by Pump and Treat - II

Lecture 15 - Remediation of contaminated GW- Calculation of remediation time and introduction to source control

Lecture 16 - Permeable Reactive Barriers - I

Lecture 17 - Permeable Reactive Barriers - II

Lecture 18 - Permeable Reactive Barriers - III

Lecture 19 - Design of Permeable Reactive Barriers

Lecture 20 - Case Study on Permeable Reactive Barriers - I

Lecture 21 - Case Study on Permeable Reactive Barriers - II

Lecture 22 - Case Study- PRB (Utah)

Lecture 23 - Case Study (Utah) (Continued...)

Lecture 24 - Mechanism of natural attenuation and the affecting factors

Lecture 25 - Introduction to natural attenuation and its types

Lecture 26 - Pathways of Contaminant Transport and Rate of Degradation of Contaminant

Lecture 27 - Rate of Degradation of Contaminant when advection is considered

Lecture 28 - Rate of Degradation of Contaminant when both diffusion and advection are considered

Lecture 29 - Example of Rate of Degradation in natural attenuation

Lecture 30 - Case study: Natural Attenuation

Lecture 31 - Results of Case Study: Natural Attenuation

- Lecture 32 - Introduction of Soil/Sediments contamination with some examples
- Lecture 33 - Case Study: Soil/Sediments Contamination and remediation by Excavation and Disposal
- Lecture 34 - Hazardous waste disposal site/TSDf
- Lecture 35 - Different type of fluxes through containment barrier
- Lecture 36 - Introduction to Solidification and Stabilisation and Case Study
- Lecture 37 - Different contaminant reactions during solidification and stabilisation
- Lecture 38 - Diffusion of contaminant through solidified form
- Lecture 39 - Calculations for fractions of binders, admixtures, waste and water used in solidification
- Lecture 40 - Discussion of TCLP approach in solidification and its examples
- Lecture 41 - Discussion of TCLP approach (contd.) and Cost estimation of Solidification
- Lecture 42 - Case Study: Solidification and Stabilization
- Lecture 43 - Chemical Treatment
- Lecture 44 - Case Study: In-Situ Chemical Oxidation - Part I
- Lecture 45 - Case Study: In-Situ Chemical Oxidation - Part II
- Lecture 46 - Case Study: In-Situ Chemical Oxidation - Part III
- Lecture 47 - Surfactant Extraction - Part I
- Lecture 48 - Surfactant Extraction - Part II
- Lecture 49 - Case Study: Surfactant Extraction - Part I
- Lecture 50 - Case Study: Surfactant Extraction - Part II
- Lecture 51 - Soil Vapor Extraction - Part I
- Lecture 52 - Soil Vapor Extraction - Part II
- Lecture 53 - Bioremediation - Part I
- Lecture 54 - Bioremediation - Part II
- Lecture 55 - Case Study: Bioremediation
- Lecture 56 - Case Study: Soil Vapor Extraction - Part I
- Lecture 57 - Case Study: Soil Vapor Extraction - Part II
- Lecture 58 - Phyto-remediation
- Lecture 59 - Conceptual Site Model
- Lecture 60 - Adaptive Design in Remediation Engineering
- Lecture 61 - Solubilization Theory - Part I
- Lecture 62 - Solubilization Theory - Part II
- Lecture 63 - Enhanced Aquifer Flushing Technologies

Lecture 1 - Introduction to Global Navigation Satellite System (GNSS)

Lecture 2 - How position is determined by the GNSS? - Part I

Lecture 3 - How position is determined by the GNSS? - Part II

Lecture 4 - How position is determined by the GNSS? - Part III

Lecture 5 - NAVSTAR - Global Positioning System

Lecture 6 - Global Navigation Satellite System (GLONASS)

Lecture 7 - BeiDou Navigation Satellite System (BDS)

Lecture 8 - Indian Regional Navigation Satellite System (IRNSS)

Lecture 9 - GALILEO

Lecture 10 - Quasi-Zenith Satellite System (QZSS)

Lecture 11 - Differential Global Navigation Satellite System (DGNSS)

Lecture 12 - Real-Time Kinematic (RTK)

Lecture 13 - Satellite Based Augmentation System (SBAS)

Lecture 14 - GNSS Errors

Lecture 15 - GNSS Correction Methods

Lecture 16 - Why altitude estimated by GNSS receivers is not very accurate

Lecture 17 - Global Navigation Satellite Systems (GNSS) Applications - I

Lecture 18 - Global Navigation Satellite Systems (GNSS) Applications - II

Lecture 19 - GNSS: Current Trends and Future

Lecture 20 - GNSS: Opportunities in India

Lecture 1 - Introduction to Geomorphology and Concept of Time Scale in a Geomorphic System

Lecture 2 - Process of Landform Development

Lecture 3 - Energy Flow in Geomorphic System and Role of Uniformitarianism Vs Catastrophism

Lecture 4 - Landform Development - Equilibrium and Evolution

Lecture 5 - Process Geomorphology - I

Lecture 6 - Process Geomorphology - II

Lecture 7 - Weathering and soil Formation Introduction - I

Lecture 8 - Weathering and soil Formation Introduction - II

Lecture 9 - Weathering and Soil Formation (Types of Weathering)

Lecture 10 - Weathering and Soil Formation (Mechanical Weathering)

Lecture 11 - Weathering and Soil Formation (Mechanical and Chemical Weathering)

Lecture 12 - Weathering and Soil Formation (Chemical and Biological Weathering)

Lecture 13 - Weathering of Silicate rocks and Weathering Products

Lecture 14 - Factors of Weathering

Lecture 15 - Soil Formation

Lecture 16 - Soil Formation Processes

Lecture 17 - Soil Classification

Lecture 18 - Mass Wasting

Lecture 19 - Classification of Mass Wasting - I

Lecture 20 - Classification of Mass Wasting - II

Lecture 21 - Hill Slope Evolution - I

Lecture 22 - Hill Slope Evolution - II

Lecture 23 - Arid Zone Geomorphology

Lecture 24 - Landforms in Dry Region

Lecture 25 - Pediment Evolution

Lecture 26 - Aeolian Processes and Landforms - I

Lecture 27 - Aeolian Processes and Landforms - II

Lecture 28 - Wind Erosional Landforms - I

Lecture 29 - Wind Erosional Landforms - II

Lecture 30 - Dune Classification - I

Lecture 31 - Dune Classification - II

- Lecture 32 - Coastal Geomorphology - I
- Lecture 33 - Coastal Geomorphology and Landforms
- Lecture 34 - Coastal Geomorphology - II
- Lecture 35 - Coastal Geomorphology - III
- Lecture 36 - Shoreline Platform
- Lecture 37 - Coastal Geomorphology - IV
- Lecture 38 - Coastal Geomorphology - V
- Lecture 39 - Coastal Geomorphology - VI
- Lecture 40 - Coastal Geomorphology - VII
- Lecture 41 - Coastal Geomorphology - VIII
- Lecture 42 - Coastal Geomorphology - IX
- Lecture 43 - Tectonic Geomorphology
- Lecture 44 - Fluvial Process
- Lecture 45 - Fluvial Process - I
- Lecture 46 - Fluvial Process - II
- Lecture 47 - Fluvial Process - III
- Lecture 48 - Fluvial Process - IV
- Lecture 49 - Fluvial Process - V and Drainage Analysis
- Lecture 50 - Fluvial Process - VI and Drainage Analysis
- Lecture 51 - Fluvial Geomorphology River System - I
- Lecture 52 - Fluvial Geomorphology River System - II
- Lecture 53 - Glacial Geomorphology - I
- Lecture 54 - Glacial Geomorphology - II (Valley Glacier)
- Lecture 55 - Glacial Geomorphology - III
- Lecture 56 - Glacial Geomorphology - IV (Geomorphologic Changes by Glacier)
- Lecture 57 - Exploration Geomorphology in Oil field Sandbody Geometry - I
- Lecture 58 - Exploration Geomorphology in Oil Field Sandbody Geometry - II
- Lecture 59 - Seismic Geomorphology - I
- Lecture 60 - Seismic Geomorphology - II

Lecture 1 - Rudiments of Remote Sensing and Advantages

Lecture 2 - Historical Perspective of development of remote sensing technology

Lecture 3 - EM spectrum, solar reflection and thermal emission

Lecture 4 - Interaction of EM radiation with atmosphere including atmospheric scattering, absorption and emission

Lecture 5 - Interaction mechanisms of EM radiation with ground, spectral response curves

Lecture 6 - Laws of Radiation and their relevance in Remote Sensing

Lecture 7 - Basis of remote sensing image representation

Lecture 8 - Various Remote Sensing Platforms

Lecture 9 - Multi-spectral scanners and imaging devices

Lecture 10 - Significant characteristics of LANDSAT, SPOT, Sentinel sensors

Lecture 11 - Prominent characteristics of IRS, Cartosat, ResourceSat sensors

Lecture 12 - Unmanned Aerial Vehicle/Drone

Lecture 13 - Passive Microwave Remote Sensing

Lecture 14 - Image characteristics and different resolutions in Remote Sensing

Lecture 15 - Different techniques of Image acquisition

Lecture 16 - Importance of digital image processing

Lecture 17 - Digital Image Processing Software

Lecture 18 - Basic image enhancement techniques

Lecture 19 - Colour representations and transformtions

Lecture 20 - Image Histograms and statistics

Lecture 21 - Atmospheric errors and corrections

Lecture 22 - Geometric transformations/Geo-referencing Technique

Lecture 23 - Digital Image Processing Software Demonstration - 1

Lecture 24 - Image enhancement techniques - 1

Lecture 25 - Image enhancement techniques - 2

Lecture 26 - Digital Image Processing Software Demonstration - 2

Lecture 27 - Spatial Filtering Techniques, Band rationing and PCA

Lecture 28 - Frequency Doman Fourier Transformation

Lecture 29 - Digital Image Processing Software Demonstration - 3

Lecture 30 - Unsupervised image classification and density slicing techniques

Lecture 31 - Supervised image classification techniques and limitations



- Lecture 32 - Digital Image Processing Software Demonstration - 4
- Lecture 33 - LiDAR Technique and applications
- Lecture 34 - Mosaicking, subsets, sub-sampling techniques and applications
- Lecture 35 - False Topographic Phenomena and correction techniques - 1
- Lecture 36 - False Topographic Phenomena and correction techniques - 2
- Lecture 37 - High Spatial Resolution Satellite Images and limitations
- Lecture 38 - Basic Image Compression techniques and different image file formats
- Lecture 39 - Hyperspectral Remote Sensing
- Lecture 40 - Digital Image vs Digital Photograph
- Lecture 41 - NDVI and other indices
- Lecture 42 - Active Microwave Remote Sensing - 1
- Lecture 43 - Active Microwave Remote Sensing - 2
- Lecture 44 - Radar Images interpretation and applications
- Lecture 45 - SAR Interferometry (InSAR) Technique - 1
- Lecture 46 - SAR Interferometry (InSAR) Technique - 2
- Lecture 47 - Principles of image interpretation
- Lecture 48 - Image interpretation of different geological landforms, rock types and structures
- Lecture 49 - Remote Sensing of Moon and Mars
- Lecture 50 - Google Earth and its Applications
- Lecture 51 - Integrated applications of RS and GIS in groundwater studies - 1
- Lecture 52 - Integrated applications of RS and GIS in groundwater studies - 2
- Lecture 53 - Applications of Remote Sensing in Earthquake Studies - 1
- Lecture 54 - Applications of Remote Sensing in Earthquake Studies - 2
- Lecture 55 - Different sources of free satellite images
- Lecture 56 - Limitations of Remote Sensing Techniques

Lecture 1 - Introduction

Lecture 2 - Shallow Foundations: General Requirements

Lecture 3 - Shallow Foundations: Bearing Capacity

Lecture 4 - Shallow Foundations: Settlement

Lecture 5 - Shallow Foundations: Numerical Examples

Lecture 6 - Combined Footings

Lecture 7 - Raft Foundations: General Requirements

Lecture 8 - Raft Foundations: Methods of Analysis

Lecture 9 - Footings under Dynamic Loads: Eccentric and Inclined Loads, A New Method

Lecture 10 - Footings under Dynamic Loads: Design Procedure and Example on a New Method

Lecture 11 - Footings under Dynamic Loads: Analytical Approaches

Lecture 12 - Footings under Dynamic Loads: Numerical on Analytical Approaches

Lecture 13 - Pile Foundations subjected to Static Vertical Load

Lecture 14 - Pile Foundations: Group Action of Piles and Numerical

Lecture 15 - Pile Foundations under Lateral Loads: Conventional and Elastic Methods

Lecture 16 - Pile Foundations under Lateral Loads: Elastic Method for Cohesionless Soils

Lecture 17 - Pile Foundations under Lateral Loads: Elastic Method for Cohesive Soils including degradation of modulus of subgrade reaction ( $k$ )

Lecture 18 - Pile Foundations under Lateral Loads: Numerical Examples

Lecture 19 - Dynamic Analysis of Piles under Vertical and Horizontal Vibrations

Lecture 20 - Dynamic Analysis of Piles under Horizontal Vibration: Continue with Numerical Example

Lecture 21 - Seismic Response of Pile Foundations - 1

Lecture 22 - Seismic Response of Pile Foundations - 2

Lecture 23 - Combined Pile-Raft Foundations (CPRF) - General

Lecture 24 - Geotechnical and Seismic Analyses of CPRF

Lecture 25 - Design of Piles in Liquefiable Soils - 1

Lecture 26 - Design of Piles in Liquefiable Soils - 2

Lecture 27 - Introduction to Well Foundations

Lecture 28 - Lateral Stability of Well Foundations

Lecture 29 - Lateral Stability, Construction and Sinking of Well Foundation

Lecture 30 - Tiltling and Shifting of Wells, Numerical Problems

[Lecture 31 - Introduction to Soil-Structure Interaction](#)

[Lecture 32 - Effects of Soil-Structure Interaction](#)

[Lecture 33 - SGM and Wave Propagation](#)

[Lecture 34 - Dispersion, Attenuation of Waves and Damping](#)

[Lecture 35 - Ground Response Analysis \(GRA\)](#)

[Lecture 36 - Soil-Pile Interaction \(SPI\)](#)

[Lecture 37 - Raft Foundations – Numerical Examples](#)

[Lecture 38 - Foundations on Slopes - 1](#)

[Lecture 39 - Foundations on Slopes - 2](#)

[Lecture 40 - Codal Provisions](#)

Lecture 1 - What is Geographic Information Systems ?

Lecture 2 - Essential Components of GIS

Lecture 3 - Different types of vector data

Lecture 4 - Concept of topology

Lecture 5 - Demonstration through GIS software

Lecture 6 - Raster data model and comparisons with vector

Lecture 7 - TIN data model and comparisons with raster

Lecture 8 - Non-spatial data (attributes) and their types

Lecture 9 - Vector data compression techniques

Lecture 10 - Demonstration through GIS software

Lecture 11 - Raster data compression techniques - 1

Lecture 12 - Raster data compression techniques - 2

Lecture 13 - Georeferencing

Lecture 14 - Pre-processing of spatial datasets - 1

Lecture 15 - Demonstration through GIS software

Lecture 16 - Pre-processing of spatial datasets - 2

Lecture 17 - Pre-processing of spatial datasets - 3

Lecture 18 - Spatial Interpolation Techniques - 1

Lecture 19 - Spatial Interpolation Techniques - 2

Lecture 20 - GIS ANALYSIS - 1

Lecture 21 - GIS Analysis - 2

Lecture 22 - GIS Analysis - 3

Lecture 23 - GIS Analysis - 4

Lecture 24 - GIS Analysis - 5

Lecture 25 - Demonstration through GIS software

Lecture 26 - GIS Analysis - 6

Lecture 27 - GIS Analysis - 7

Lecture 28 - Attributes Classification Methods

Lecture 29 - Special database systems and their types - 1

Lecture 30 - Demonstration through GIS software

Lecture 31 - Spatial database systems and their types - 2

- Lecture 32 - Concept of NoData in Raster
- Lecture 33 - Different map projections
- Lecture 34 - Concept of digital elevation model (DEM) and how it is represented
- Lecture 35 - Demonstration through GIS software
- Lecture 36 - Various techniques to generate digital elevation model - 1
- Lecture 37 - Various techniques to generate digital elevation model - 2
- Lecture 38 - Various techniques to generate digital elevation model - 3
- Lecture 39 - Digital Elevation Models and different types of resolutions
- Lecture 40 - Demonstration through GIS software
- Lecture 41 - How to assess quality of a DEM?
- Lecture 42 - Integration of DEMs with satellite data
- Lecture 43 - Demonstration through GIS software...
- Lecture 44 - Common derivatives of DEMs - Slope and aspect - 1
- Lecture 45 - Common derivatives of DEMs - Slope and aspect - 2
- Lecture 46 - Common derivatives of DEMs - Slope and aspect - 3
- Lecture 47 - Demonstration through GIS software
- Lecture 48 - DEMs derivatives - 1
- Lecture 49 - DEMs derivatives - 2
- Lecture 50 - DEMs derivatives - 3
- Lecture 51 - DEMs derivatives - 4
- Lecture 52 - Shaded relief models and their applications
- Lecture 53 - DEM based Surface Hydrologic Modelling - 1
- Lecture 54 - DEM based Surface Hydrologic Modelling - 2
- Lecture 55 - DEMs and Dam Simulation and its application in groundwater hydrology
- Lecture 56 - Applications of DEMs in Viewshed and Flood Hazard Mapping
- Lecture 57 - Applications of DEMs in solar and wind energy potential estimations
- Lecture 58 - DEMs Sources, limitations and future of Digital Elevation Models
- Lecture 59 - Errors in GIS and key elements of maps
- Lecture 60 - Limitations of GIS

- Lecture 1 - Importance of water and wastewater treatment
- Lecture 2 - Life expectancy and real-world scenario
- Lecture 3 - Course outline
- Lecture 4 - Review of fundamentals
- Lecture 5 - Mass balance
- Lecture 6 - Mass Balance: Batch reactor, CSTR, and Plug flow reactors
- Lecture 7 - Mass balance: Comparison of CSTR and Plug flow reactor
- Lecture 8 - Mass Balance: Non ideal system and Water quality parameters
- Lecture 9 - Water quality: DO and ways to measure it
- Lecture 10 - Water quality: Nutrients in water
- Lecture 11 - Water quality: Total suspended solids and Pathogens
- Lecture 12 - Wastewater treatment plant: basic principals
- Lecture 13 - Wastewater treatment plant: Preliminary treatment
- Lecture 14 - Wastewater treatment plant: Sedimentation and basics
- Lecture 15 - Sedimentation: Discrete and Flocculant settling
- Lecture 16 - Design of primary settling tank
- Lecture 17 - Biological treatment: BOD and Nutrient removal
- Lecture 18 - Analysis of biological removal process(ASP)
- Lecture 19 - Activated sludge process: Material balance for aeration basin
- Lecture 20 - Oxygen transfer: types and basic principals
- Lecture 21 - Relevance of F/M ratio and Design Parameters of Activated Sludge Process
- Lecture 22 - Sludge Bulking and Activated Sludge Variations
- Lecture 23 - Sequencing Batch Reactor
- Lecture 24 - Nitrogen Removal - I
- Lecture 25 - Nitrogen Removal - II and Phosphorus Removal - I
- Lecture 26 - Phosphorus Removal - II
- Lecture 27 - Secondary Clarifiers and Attached Growth System
- Lecture 28 - Disinfection
- Lecture 29 - Chlorination Disinfection
- Lecture 30 - Disinfection By-products (DBPs) and Disinfectant Removal
- Lecture 31 - Water demand

- Lecture 32 - Water Quality Parameters
- Lecture 33 - Overview of Water Treatment
- Lecture 34 - Physico-Chemical treatment
- Lecture 35 - Coagulation - I
- Lecture 36 - Coagulation - II
- Lecture 37 - Rapid Mixing
- Lecture 38 - Flocculation - I
- Lecture 39 - Flocculation - II
- Lecture 40 - Flocculent settling
- Lecture 41 - Filtration
- Lecture 42 - Depth filtration
- Lecture 43 - Design of Sand filter and Surface filtration
- Lecture 44 - Disinfection
- Lecture 45 - Hardness - I
- Lecture 46 - Hardness - II
- Lecture 47 - Lime-Soda softening - I
- Lecture 48 - Lime-Soda softening - II
- Lecture 49 - Recarbonation
- Lecture 50 - Types of Softening Basin and Adsorption
- Lecture 51 - Adsorption
- Lecture 52 - Adsorption Isotherms
- Lecture 53 - Ion Exchange
- Lecture 54 - Nanofiltration and RO
- Lecture 55 - Aeration: Removal of Fe and Mn
- Lecture 56 - Residual Management
- Lecture 57 - Sludge Thickening
- Lecture 58 - Stabilization of Sludge
- Lecture 59 - Anaerobic and Aerobic digestion of sludge
- Lecture 60 - Conditioning, Dewatering and Disposal of Sludge

Lecture 1 - Introduction

Lecture 2 - Minerals and Rock Classes

Lecture 3 - Mineral Identification Procedure

Lecture 4 - Rock Identification Procedure

Lecture 5 - Geological Structures and Discontinuities

Lecture 6 - Spherical Representation of Geological Data - 1

Lecture 7 - Spherical Representation of Geological Data - 2

Lecture 8 - Spherical Representation of Geological Data - 3

Lecture 9 - Application of Graphical Representation of Geological Data

Lecture 10 - Laboratory Testing of Rocks - Sampling

Lecture 11 - Laboratory testing of Rocks - Preparations and UCS

Lecture 12 - Factors Influencing UCS and Modes of Failure in Compression

Lecture 13 - Failure Mechanism and Post-Failure Behaviour in Compression, Indirect Method for UCS

Lecture 14 - Indirect Method for UCS, Brazilian Test, Schmidt Rebound Hardness Test

Lecture 15 - Sound Velocity Test, Slake Durability Test, Swelling Pressure and Free Swell Test and Void Index Test

Lecture 16 - Shear Tests - 1

Lecture 17 - Shear Tests - 2

Lecture 18 - Engineering Classification of Intact Rocks, Concept of Rock Mass, RQD

Lecture 19 - Concept of Rock Mass, Factors Affecting Discontinuities

Lecture 20 - Factors Affecting Discontinuities

Lecture 21 - Classification of Rock Mass: Rock Mass Rating (RMR) - 1

Lecture 22 - Classification of Rock Mass: Rock Mass Rating (RMR) - 2

Lecture 23 - Classification of Rock Mass: Rock Mass Quality (Q-system) - 1

Lecture 24 - Classification of Rock Mass: Rock Mass Quality (Q-system) - 2

Lecture 25 - Classification of Rock Mass: Geological Strength Index (GSI)

Lecture 26 - Strength Criteria for Isotropic and Anisotropic Rock - 1

Lecture 27 - Strength Criteria for Isotropic and Anisotropic Rocks -2, Mohr's Failure Theory

Lecture 28 - Mohr-Coulomb Failure Criterion

Lecture 29 - Mohr-Coulomb Failure Criterion, Coulomb Navier Failure Criterion

Lecture 30 - Concept of Instantaneous  $c$  and  $\phi$ : Balmer Approach

Lecture 31 - Empirical Failure Criteria: Basics of Regression Analysis



- Lecture 32 - Hoek and Brown Criterion (1980)
- Lecture 33 - Parameters of Failure Criteria
- Lecture 34 - Failure Criteria for Rock Mass
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- Lecture 2 - Classification of ground modification techniques
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Lecture 8 - Linear Programming: Graphical method

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Lecture 15 - Dynamic Programming: Water allocation problem

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Lecture 21 - Reservoir capacity using Linear Programming (1)

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Lecture 2 - Equations of motion for continuous systems and Rayleigh's quotient

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Lecture 5 - Beam elements. Reference system. Assembly of matrices. Imposition of BCS. Final equation of motion

Lecture 6 - FE modelling of planar structures

Lecture 7 - FE modelling of planar structures (Continued...)

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Lecture 11 - Twisting of circular bars and rectangular bars. Analysis of grids

Lecture 12 - 3D frames

Lecture 13 - Mathematical preliminaries and terminologies; Euler's forward and backward difference methods

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Lecture 16 - Road Damage Intensity Scale; and Seismic Vulnerability assessment

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Lecture 20 - Interpretation of Earthquake records (Continued...); Time Domain Parameters

Lecture 21 - Time Domain Parameters (Continued...)

Lecture 22 - Duration parameters; Duration Prediction Equations

Lecture 23 - Frequency Domain Characteristics; Response Spectrum

Lecture 24 - Fourier Spectrum

Lecture 25 - Seismic Source Parameters;

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