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NPTEL : Stochastic Processes (Mathematics)

Co-ordinators : Dr. S. Dharmaraja

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NPTEL : Linear programming and Extensions (Mathematics)

Co-ordinators : Prof. Prabha Sharma

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Lecture 3 - Moving from one basic feasible solution to another, optimality criteria

Lecture 4 - Basic feasible solutions, existence & derivation

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Lecture 6 - Direction of a polyhedron, correspondence between bfs and extreme points

Lecture 7 - Representation theorem, LPP solution is a bfs, Assignment 1

Lecture 8 - Development of the Simplex Algorithm, Unboundedness, Simplex Tableau

Lecture 9 - Simplex Tableau & algorithm ,Cycling, Bland's anti-cycling rules, Phase I & Phase II

Lecture 10 - Big-M method,Graphical solutions, adjacent extreme pts and adjacent bfs

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NPTEL : Convex Optimization (Mathematics)

Co-ordinators : Dr. Joydeep Dutta

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NPTEL : Foundations of Optimization (Mathematics)

Co-ordinators : Dr. Joydeep Dutta

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Lecture 2 - Installation and Working with R

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Lecture 6 - Operations with Matrices

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Lecture 9 - Sampling, Sampling Unit, Population and Sample

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Lecture 16 - SRSWOR and SRSWR with R with sample Package

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Lecture 29 - Stratified Random Sampling : Estimation of Population Mean, Population Variance and Confidence Interval

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Lecture 31 - Stratified Random Sampling : Drawing of Sample Using sampling and strata Packages in R

- Lecture 32 - Stratified Random Sampling : Drawing of Sample Using survey Package in R
- Lecture 33 - Bootstrap Methodology : What is Bootstrap and Methodology
- Lecture 34 - Bootstrap Methodology : EDF, Bootstrap Bias and Bootstrap Standard Errors
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- Lecture 36 - Bootstrap Methodology : Bootstrap Confidence Interval
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- Lecture 38 - Bootstrap Methodology : Example of Bootstrap Analysis Using boot Package
- Lecture 39 - Introduction to Linear Models and Regression : Introduction and Basic Concepts
- Lecture 40 - Simple Linear Regression Analysis : Basic Concepts and Least Squares Estimation
- Lecture 41 - Simple Linear Regression Analysis : Fitting Linear Model With R Software
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- Lecture 43 - Simple Linear Regression Analysis : Maximum Likelihood and Confidence Interval Estimation
- Lecture 44 - Simple Linear Regression Analysis : Test of Hypothesis and Confidence Interval Estimation With R
- Lecture 45 - Multiple Linear Regression Analysis : Basic Concepts
- Lecture 46 - Multiple Linear Regression Analysis : OLSE, Fitted Model and Residuals
- Lecture 47 - Multiple Linear Regression Analysis : Model Fitting With R Software
- Lecture 48 - Multiple Linear Regression Analysis : Properties of OLSE and Maximum Likelihood Estimation
- Lecture 49 - Multiple Linear Regression Analysis : Test of Hypothesis and Confidence Interval Estimation on Individual Regression Coefficients
- Lecture 50 - Analysis of Variance and Implementation in R Software
- Lecture 51 - Goodness of Fit and Implementation in R Software
- Lecture 52 - Variable Selection using LASSO Regression : Introduction and Basic Concepts
- Lecture 53 - Variable Selection using LASSO Regression : LASSO with R

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- Lecture 2 - Sigma-fields and Measurable spaces
- Lecture 3 - Fields and Generating sets for Sigma-fields
- Lecture 4 - Borel Sigma-field on \mathbb{R} and other sets
- Lecture 5 - Limits of sequences of sets and Monotone classes
- Lecture 6 - Measures and Measure spaces
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- Lecture 13 - Algebraic properties of Measurable functions
- Lecture 14 - Limiting behaviour of measurable functions
- Lecture 15 - Random Variables and Random Vectors
- Lecture 16 - Law or Distribution of an RV
- Lecture 17 - Distribution Function of an RV
- Lecture 18 - Decomposition of Distribution functions
- Lecture 19 - Construction of RVs with a specified law
- Lecture 20 - Caratheodery Extension Theorem
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- Lecture 23 - Lebesgue-Stieltjes Measures
- Lecture 24 - Properties of Lebesgue Measure on \mathbb{R}
- Lecture 25 - Distribution Functions and Probability Measures in higher dimensions
- Lecture 26 - Integration of measurable functions
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Lecture 2 - Basics of Linear Algebra

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Lecture 6 - Method to Find Eigenvalues and Eigenvectors, Diagonalization of Matrices

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Lecture 12 - Analytic Functions, C-R Equations

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Lecture 21 - Classification of Singularities, Residue and Residue Theorem

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NPTEL : Functional Analysis (Mathematics)

Co-ordinators : Prof. P.D. Srivastava

- Lecture 1 - Metric Spaces with Examples
- Lecture 2 - Holder Inequality and Minkowski Inequality
- Lecture 3 - Various Concepts in a Metric Space
- Lecture 4 - Separable Metrics Spaces with Examples
- Lecture 5 - Convergence, Cauchy Sequence, Completeness
- Lecture 6 - Examples of Complete and Incomplete Metric Spaces
- Lecture 7 - Completion of Metric Spaces + Tutorial
- Lecture 8 - Vector Spaces with Examples
- Lecture 9 - Normed Spaces with Examples
- Lecture 10 - Banach Spaces and Schauder Basis
- Lecture 11 - Finite Dimensional Normed Spaces and Subspaces
- Lecture 12 - Compactness of Metric/Normed Spaces
- Lecture 13 - Linear Operators-definition and Examples
- Lecture 14 - Bounded Linear Operators in a Normed Space
- Lecture 15 - Bounded Linear Functionals in a Normed Space
- Lecture 16 - Concept of Algebraic Dual and Reflexive Space
- Lecture 17 - Dual Basis & Algebraic Reflexive Space
- Lecture 18 - Dual Spaces with Examples
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- Lecture 21 - Inner Product & Hilbert Space
- Lecture 22 - Further Properties of Inner Product Spaces
- Lecture 23 - Projection Theorem, Orthonormal Sets and Sequences
- Lecture 24 - Representation of Functionals on a Hilbert Spaces
- Lecture 25 - Hilbert Adjoint Operator
- Lecture 26 - Self Adjoint, Unitary & Normal Operators
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- Lecture 29 - Total Orthonormal Sets And Sequences
- Lecture 30 - Partially Ordered Set and Zorns Lemma
- Lecture 31 - Hahn Banach Theorem for Real Vector Spaces

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- Lecture 2 - Single - Step Methods for IVPs
- Lecture 3 - Analysis of Single Step Methods
- Lecture 4 - Runge - Kutta Methods for IVPs
- Lecture 5 - Higher Order Methods/Equations
- Lecture 6 - Error - Stability - Convergence of Single Step Methods
- Lecture 7 - Tutorial - I
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- Lecture 9 - Multi-Step Methods (Explicit)
- Lecture 10 - Multi-Step Methods (Implicit)
- Lecture 11 - Convergence and Stability of multi step methods
- Lecture 12 - General methods for absolute stability
- Lecture 13 - Stability Analysis of Multi Step Methods
- Lecture 14 - Predictor - Corrector Methods
- Lecture 15 - Some Comments on Multi - Step Methods
- Lecture 16 - Finite Difference Methods - Linear BVPs
- Lecture 17 - Linear/Non - Linear Second Order BVPs
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- Lecture 22 - Introduction to First Order PDE
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- Lecture 25 - Implicit Methods for Parabolic PDEs
- Lecture 26 - Consistency, Stability and Convergence
- Lecture 27 - Other Numerical Methods for Parabolic PDEs
- Lecture 28 - Tutorial - IV
- Lecture 29 - Matrix Stability Analysis of Finite Difference Scheme
- Lecture 30 - Fourier Series Stability Analysis of Finite Difference Scheme
- Lecture 31 - Finite Difference Approximations to Elliptic PDEs - I

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NPTEL : Optimization (Mathematics)

Co-ordinators : Prof. A. Goswami, Dr. Debjani Chakraborty

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Lecture 3 - Geometry of LPP and Graphical Solution of LPP

Lecture 4 - Solution of LPP : Simplex Method

Lecture 5 - Big - M Method

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Lecture 20 - Travelling Salesman Problem

Lecture 21 - Classical optimization techniques : Single variable optimization

Lecture 22 - Unconstrained multivariable optimization

Lecture 23 - Nonlinear programming with equality constraint

Lecture 24 - Nonlinear programming KKT conditions

Lecture 25 - Numerical optimization : Region elimination techniques

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NPTEL : Probability and Statistics (Mathematics)

Co-ordinators : Prof. Somesh Kumar

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NPTEL : Regression Analysis (Mathematics)

Co-ordinators : Dr. Soumen Maity

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Lecture 13 - Selecting the BEST Regression model (Continued...3)

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Lecture 15 - Multicollinearity (Continued...1)

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NPTEL : NOC:Laplace Transform (Mathematics)

Co-ordinators : Prof. Indrava Roy

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[Lecture 63 - Concluding Remarks](#)

[Lecture 64 - Course Review](#)

Lecture 1 - Commutative Algebra - Part 1

Lecture 2 - Commutative Algebra - Part 2

Lecture 3 - Commutative Algebra - Part 3

Lecture 4 - Commutative Algebra - Part 4

Lecture 5 - Commutative Algebra - Part 5

Lecture 6 - Tutorial 1 : Cayley-Hamilton Theorem, Nakayama's Lemma

Lecture 7 - Commutative Algebra - Part 6

Lecture 8 - Commutative Algebra - Part 7

Lecture 9 - Commutative Algebra - Part 8

Lecture 10 - Affine Algebraic Sets - Part 1

Lecture 11 - Affine Algebraic Sets - Part 2

Lecture 12 - Tutorial 2 : Noether Normalization Lemma, Some Important Results in Dimension Theory

Lecture 13 - Regular Morphisms

Lecture 14 - Abstract Algebraic Sets

Lecture 15 - Zariski Topology on Affine Space

Lecture 16 - Irreducible Affine Algebraic Sets

Lecture 17 - Ring of Regular Functions

Lecture 18 - Projective Space

Lecture 19 - Tutorial 3 : Some Applications of Dimension Theory

Lecture 20 - Zariski Topology on Projective Space

Lecture 21 - Affine Open Cover of Projective Space

Lecture 22 - Projective and Quasi-Projective Varieties

Lecture 23 - Regular Functions on Quasi-Projective Varieties

Lecture 24 - Presheaves and Sheaves

Lecture 25 - Morphism of Presheaves/Sheaves

Lecture 26 - Tutorial 4 : More Applications of Dimension Theory

Lecture 27 - A Brief Overview of Sheaf Theory - Part 1

Lecture 28 - A Brief Overview of Sheaf Theory - Part 2

Lecture 29 - A Brief Overview of Sheaf Theory - Part 3

Lecture 30 - Prevarieties

Lecture 31 - Sheaf of Regular Functions

Lecture 32 - Ring of Germs of Regular Functions at a point, Field of Rational Functions

Lecture 33 - Tutorial 5 : Sheafification

Lecture 34 - Ring of Regular Functions, Local Ring at a Point, and Field of Rational Functions of an Affine Variety

Lecture 35 - Equivalence of Categories of the Category of Affine Varieties over a Field k and the Category

Lecture 36 - Equivalence of Categories of the Category of Affine Varieties over a Field k (Continued...)

Lecture 37 - Some Examples, Open Immersions and Closed Immersions

Lecture 38 - Product of Quasi-affine Varieties

Lecture 39 - Diagonal Morphisms, Abstract Varieties

Lecture 40 - Tutorial 6 : Normal Varieties and Normalization of a Variety

Lecture 41 - Projective Varieties Revisited - Part 1

Lecture 42 - Projective Varieties Revisited - Part 2

Lecture 43 - Global Regular Functions on Projective Varieties are Constants - Part 1

Lecture 44 - Global Regular Functions on Projective Varieties are Constants - Part 2

Lecture 45 - Product of Prevarieties - Part 1

Lecture 46 - Product of Prevarieties - Part 2

Lecture 47 - Tutorial 7 : A Result on Tensor Products of k -algebras

Lecture 48 - Morphisms of Prevarieties - Part 1

Lecture 49 - Morphisms of Prevarieties - Part 2

Lecture 50 - Finite Morphisms - Part 1

Lecture 51 - Finite Morphisms - Part 2

Lecture 52 - Fiber Products

Lecture 53 - Tutorial 8 : Finite Morphisms

Lecture 54 - Immersions

Lecture 55 - Fiber Products, Separatedness

Lecture 56 - Criterion of Separatedness

Lecture 57 - Proper Morphisms and Complete Varieties

Lecture 58 - Tutorial 9 : Closed Immersions and Graph of a Morphism

Lecture 59 - Projective Varieties are Complete

Lecture 60 - Zariski Tangent Space, Singular and Nonsingular Points

Lecture 61 - Smooth Points Form a Non-empty Open Subset

Lecture 62 - Blow-Ups, Rational Maps and Birational Maps

Lecture 63 - Tutorial 10 : Zariski Tangent Space at a Point of an Affine Variety

Lecture 64 - Blow-Ups (Continued...)

[Lecture 65 - Smooth Morphisms](#)

[Lecture 66 - Bertini's Theorem](#)

[Lecture 67 - Sard's Theorem](#)

[Lecture 68 - Tutorial 11 : Dimension of fiber of a morphism](#)

[Lecture 69 - Introduction to Affine Schemes - Spectrum of a Ring](#)

[Lecture 70 - Introduction to Affine Schemes - Topology on Spec A](#)

[Lecture 71 - Introduction to Affine Schemes - Topology on Spec A \(Continued...\)](#)

[Lecture 72 - Introduction to Affine Schemes - Sheaf Structure on Spec A](#)

[Lecture 73 - Abstract Non-singular Curves - Part 1](#)

[Lecture 74 - Abstract Non-singular Curves - Part 2](#)

[Lecture 75 - Tutorial 12 : Extension of Regular Functions](#)

Lecture 1 - Introduction to the theory of sets

Lecture 2 - Set operation and laws of set operation

Lecture 3 - The principle of inclusion and exclusion

Lecture 4 - Application of the principle of inclusion and exclusion

Lecture 5 - Fundamentals of logic

Lecture 6 - Logical Inferences

Lecture 7 - Methods of proof of an implication

Lecture 8 - First order logic (1)

Lecture 9 - First order logic (2)

Lecture 10 - Rules of inference for quantified propositions

Lecture 11 - Mathematical Induction (1)

Lecture 12 - Mathematical Induction (2)

Lecture 13 - Sample space, events

Lecture 14 - Probability, conditional probability

Lecture 15 - Independent events, Bayes theorem

Lecture 16 - Information and mutual information

Lecture 17 - Basic definition

Lecture 18 - Isomorphism and sub graphs

Lecture 19 - Walks, paths and circuits operations on graphs

Lecture 20 - Euler graphs, Hamiltonian circuits

Lecture 21 - Shortest path problem

Lecture 22 - Planar graphs

Lecture 23 - Basic definition

Lecture 24 - Properties of relations

Lecture 25 - Graph of relations

Lecture 26 - Matrix of relation

Lecture 27 - Closure of relation (1)

Lecture 28 - Closure of relation (2)

Lecture 29 - Warshall's algorithm

Lecture 30 - Partially ordered relation

Lecture 31 - Partially ordered sets

[Lecture 32 - Lattices](#)

[Lecture 33 - Boolean algebra](#)

[Lecture 34 - Boolean function \(1\)](#)

[Lecture 35 - Boolean function \(2\)](#)

[Lecture 36 - Discrete numeric function](#)

[Lecture 37 - Generating function](#)

[Lecture 38 - Introduction to recurrence relations](#)

[Lecture 39 - Second order recurrence relation with constant coefficients \(1\)](#)

[Lecture 40 - Second order recurrence relation with constant coefficients \(2\)](#)

[Lecture 41 - Application of recurrence relation](#)

Lecture 1 - Introduction to linear differential equations

Lecture 2 - Linear dependence, independence and Wronskian of functions

Lecture 3 - Solution of second-order homogenous linear differential equations with constant coefficients - I

Lecture 4 - Solution of second-order homogenous linear differential equations with constant coefficients - II

Lecture 5 - Method of undetermined coefficients

Lecture 6 - Methods for finding Particular Integral for second-order linear differential equations with constant coefficients - I

Lecture 7 - Methods for finding Particular Integral for second-order linear differential equations with constant coefficients - II

Lecture 8 - Methods for finding Particular Integral for second-order linear differential equations with constant coefficients - III

Lecture 9 - Euler-Cauchy equations

Lecture 10 - Method of reduction for second-order linear differential equations

Lecture 11 - Method of variation of parameters

Lecture 12 - Solution of second order differential equations by changing dependent variable

Lecture 13 - Solution of second order differential equations by changing independent variable

Lecture 14 - Solution of higher-order homogenous linear differential equations with constant coefficients

Lecture 15 - Methods for finding Particular Integral for higher-order linear differential equations

Lecture 16 - Formulation of Partial differential equations

Lecture 17 - Solution of Lagrange's equation - I

Lecture 18 - Solution of Lagrange's equation - II

Lecture 19 - Solution of first order nonlinear equations - I

Lecture 20 - Solution of first order nonlinear equations - II

Lecture 21 - Solution of first order nonlinear equations - III

Lecture 22 - Solution of first order nonlinear equations - IV

Lecture 23 - Introduction to Laplace transforms

Lecture 24 - Laplace transforms of some standard functions

Lecture 25 - Existence theorem for Laplace transforms

Lecture 26 - Properties of Laplace transforms - I

Lecture 27 - Properties of Laplace transforms - II

Lecture 28 - Properties of Laplace transforms - III

Lecture 29 - Properties of Laplace transforms - IV

Lecture 30 - Convolution theorem for Laplace transforms - I

Lecture 31 - Convolution theorem for Laplace transforms - II

Lecture 32 - Initial and final value theorems for Laplace transforms

Lecture 33 - Laplace transforms of periodic functions

Lecture 34 - Laplace transforms of Heaviside unit step function

Lecture 35 - Laplace transforms of Dirac delta function

Lecture 36 - Applications of Laplace transforms - I

Lecture 37 - Applications of Laplace transforms - II

Lecture 38 - Applications of Laplace transforms - III

Lecture 39 - Z-transform and inverse Z-transform of elementary functions

Lecture 40 - Properties of Z-transforms - I

Lecture 41 - Properties of Z-transforms - II

Lecture 42 - Initial and final value theorem for Z-transforms

Lecture 43 - Convolution theorem for Z-transforms

Lecture 44 - Applications of Z-transforms - I

Lecture 45 - Applications of Z-transforms - II

Lecture 46 - Applications of Z-transforms - III

Lecture 47 - Fourier series and its convergence - I

Lecture 48 - Fourier series and its convergence - II

Lecture 49 - Fourier series of even and odd functions

Lecture 50 - Fourier half-range series

Lecture 51 - Parseval's Identity

Lecture 52 - Complex form of Fourier series

Lecture 53 - Fourier integrals

Lecture 54 - Fourier sine and cosine integrals

Lecture 55 - Fourier transforms

Lecture 56 - Fourier sine and cosine transforms

Lecture 57 - Convolution theorem for Fourier transforms

Lecture 58 - Applications of Fourier transforms to BVP - I

Lecture 59 - Applications of Fourier transforms to BVP - II

Lecture 60 - Applications of Fourier transforms to BVP - III

Lecture 1 - Definition and classification of linear integral equations

Lecture 2 - Conversion of IVP into integral equations

Lecture 3 - Conversion of BVP into an integral equations

Lecture 4 - Conversion of integral equations into differential equations

Lecture 5 - Integro-differential equations

Lecture 6 - Fredholm integral equation with separable kernel: Theory

Lecture 7 - Fredholm integral equation with separable kernel: Examples

Lecture 8 - Solution of integral equations by successive substitutions

Lecture 9 - Solution of integral equations by successive approximations

Lecture 10 - Solution of integral equations by successive approximations: Resolvent kernel

Lecture 11 - Fredholm integral equations with symmetric kernels: Properties of eigenvalues and eigenfunctions

Lecture 12 - Fredholm integral equations with symmetric kernels: Hilbert Schmidt theory

Lecture 13 - Fredholm integral equations with symmetric kernels: Examples

Lecture 14 - Construction of Green function - I

Lecture 15 - Construction of Green function - II

Lecture 16 - Green function for self adjoint linear differential equations

Lecture 17 - Green function for non-homogeneous boundary value problem

Lecture 18 - Fredholm alternative theorem - I

Lecture 19 - Fredholm alternative theorem - II

Lecture 20 - Fredholm method of solutions

Lecture 21 - Classical Fredholm theory: Fredholm first theorem - I

Lecture 22 - Classical Fredholm theory: Fredholm first theorem - II

Lecture 23 - Classical Fredholm theory: Fredholm second theorem and third theorem

Lecture 24 - Method of successive approximations

Lecture 25 - Neumann series and resolvent kernels - I

Lecture 26 - Neumann series and resolvent kernels - II

Lecture 27 - Equations with convolution type kernels - I

Lecture 28 - Equations with convolution type kernels - II

Lecture 29 - Singular integral equations - I

Lecture 30 - Singular integral equations - II

Lecture 31 - Cauchy type integral equations - I

- Lecture 32 - Cauchy type integral equations - II
- Lecture 33 - Cauchy type integral equations - III
- Lecture 34 - Cauchy type integral equations - IV
- Lecture 35 - Cauchy type integral equations - V
- Lecture 36 - Solution of integral equations using Fourier transform
- Lecture 37 - Solution of integral equations using Hilbert transform - I
- Lecture 38 - Solution of integral equations using Hilbert transform - II
- Lecture 39 - Calculus of variations: Introduction
- Lecture 40 - Calculus of variations: Basic concepts - I
- Lecture 41 - Calculus of variations: Basic concepts - II
- Lecture 42 - Calculus of variations: Basic concepts and Euler equation
- Lecture 43 - Euler equation: Some particular cases
- Lecture 44 - Euler equation : A particular case and Geodesics
- Lecture 45 - Brachistochrone problem and Euler equation - I
- Lecture 46 - Euler's equation - II
- Lecture 47 - Functions of several independent variables
- Lecture 48 - Variational problems in parametric form
- Lecture 49 - Variational problems of general type
- Lecture 50 - Variational derivative and invariance of Euler's equation
- Lecture 51 - Invariance of Euler's equation and isoperimetric problem - I
- Lecture 52 - Isoperimetric problem - II
- Lecture 53 - Variational problem involving a conditional extremum - I
- Lecture 54 - Variational problem involving a conditional extremum - II
- Lecture 55 - Variational problems with moving boundaries - I
- Lecture 56 - Variational problems with moving boundaries - II
- Lecture 57 - Variational problems with moving boundaries - III
- Lecture 58 - Variational problems with moving boundaries; One sided variation
- Lecture 59 - Variational problem with a movable boundary for a functional dependent on two functions
- Lecture 60 - Hamilton's principle: Variational principle of least action

NPTEL : NOC:Nonlinear Programming (Mathematics)

Co-ordinators : S. K. Gupta

Lecture 1 - Convex Sets and Functions

Lecture 2 - Properties of Convex Functions - I

Lecture 3 - Properties of Convex Functions - II

Lecture 4 - Properties of Convex Functions- III

Lecture 5 - Convex Programming Problems

Lecture 6 - KKT optimality conditions

Lecture 7 - Quadratic Programming Problems - I

Lecture 8 - Quadratic Programming Problems - II

Lecture 9 - Separable Programming - I

Lecture 10 - Separable Programming - II

Lecture 11 - Geometric Programming - I

Lecture 12 - Geometric Programming - II

Lecture 13 - Geometric Programming - III

Lecture 14 - Dynamic Programming - I

Lecture 15 - Dynamic Programming - II

Lecture 16 - Dynamic programming approach to find shortest path in any network

Lecture 17 - Dynamic Programming - IV

Lecture 18 - Search Techniques - I

Lecture 19 - Search Techniques - II

Lecture 20 - Search Techniques - III

Lecture 1 - Introduction to error analysis and linear systems

Lecture 2 - Gaussian elimination with Partial pivoting

Lecture 3 - LU decomposition

Lecture 4 - Jacobi and Gauss Seidel methods

Lecture 5 - Iterative methods-II

Lecture 6 - Introduction to Non-linear equations and Bisection method

Lecture 7 - Regula Falsi and Secant methods

Lecture 8 - Newton-Raphson method

Lecture 9 - Fixed point iteration method

Lecture 10 - System of Nonlinear equations

Lecture 11 - Introduction to Eigenvalues and Eigenvectors

Lecture 12 - Similarity Transformations and Gershgorin Theorem

Lecture 13 - Jacobi's Method for Computing Eigenvalues

Lecture 14 - Power Method

Lecture 15 - Inverse Power Method

Lecture 16 - Interpolation - Part I (Introduction to Interpolation)

Lecture 17 - Interpolation - Part II (Some basic operators and their properties)

Lecture 18 - Interpolation - Part III (Newton's Forward/ Backward difference and derivation of general error)

Lecture 19 - Interpolation - Part IV (Error in approximating a function by a polynomial using Newton's Forward and Backward difference formula)

Lecture 20 - Interpolation - Part V (Solving problems using Newton's Forward and Backward difference formula)

Lecture 21 - Interpolation - Part VI (Central difference formula)

Lecture 22 - Interpolation - Part VII (Lagrange interpolation formula with examples)

Lecture 23 - Interpolation - Part VIII (Divided difference interpolation with examples)

Lecture 24 - Interpolation - Part IX (Hermite's interpolation with examples)

Lecture 25 - Numerical differentiation - Part I (Introduction to numerical differentiation by interpolation formula)

Lecture 26 - Numerical differentiation - Part II (Numerical differentiation based on Lagrange's interpolation with examples)

Lecture 27 - Numerical differentiation - Part III (Numerical differentiation based on Divided difference formula with examples)

Lecture 28 - Numerical differentiation - Part IV (Maxima and minima of a tabulated function and differentiation errors)

Lecture 29 - Numerical differentiation - Part V (Differentiation based on finite difference operators)

Lecture 30 - Numerical differentiation - Part VI (Method of undetermined coefficients and Derivatives with unequal intervals)

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Lecture 31 - Numerical Integration - Part I (Methodology of Numerical Integration and Rectangular rule)

Lecture 32 - Numerical Integration - Part II (Quadrature formula and Trapezoidal rule with associated errors) Numerical Integration Part-I (Methodology of Numerical Integration and Rectangular rule)

Lecture 33 - Numerical Integration - Part III (Simpsons 1/3rd rule with associated errors)

Lecture 34 - Numerical Integration - Part IV (Composite Simpsons 1/3rd rule and Simpsons 3/8th rule with examples)

Lecture 35 - Numerical Integration - Part V (Gauss Legendre 2-point and 3-point formula with examples)

Lecture 36 - Introduction to Ordinary Differential equations

Lecture 37 - Numerical methods for ODE-1

Lecture 38 - Numerical Methods - II

Lecture 39 - R-K Methods for solving ODEs

Lecture 40 - Multi-step Method for solving ODEs

- Lecture 1 - Matrix Operations and Types of Matrices
- Lecture 2 - Determinant of a Matrix
- Lecture 3 - Rank of a Matrix
- Lecture 4 - Vector Space - I
- Lecture 5 - Vector Space - II
- Lecture 6 - Linear dependence and independence
- Lecture 7 - Bases and Dimension - I
- Lecture 8 - Bases and Dimension - II
- Lecture 9 - Linear Transformation - I
- Lecture 10 - Linear Transformation - II
- Lecture 11 - Orthogonal Subspaces
- Lecture 12 - Row Space, Column Space and Null Space
- Lecture 13 - Eigen Values and Eigen Vectors - I
- Lecture 14 - Eigen Values and Eigen Vectors - II
- Lecture 15 - Diagonalizable Matrices
- Lecture 16 - Orthogonal Sets
- Lecture 17 - Gram Schmidt orthogonalization and orthogonal bases
- Lecture 18 - Introduction to Matlab
- Lecture 19 - Sign Integer Representation
- Lecture 20 - Computer Representation of Numbers
- Lecture 21 - Floating Point Representation
- Lecture 22 - Round-off Error
- Lecture 23 - Error Propagation in Computer Arithmetic
- Lecture 24 - Addition and Multiplication of Floating Point Numbers
- Lecture 25 - Conditioning and Condition Numbers - I
- Lecture 26 - Conditioning and Condition Numbers - II
- Lecture 27 - Stability of Numerical Algorithms - I
- Lecture 28 - Stability of Numerical Algorithms - II
- Lecture 29 - Vector Norms - I
- Lecture 30 - Vector Norms - II
- Lecture 31 - Matrix Norms - I

- Lecture 32 - Matrix Norms - II
- Lecture 33 - Convergent Matrices - I
- Lecture 34 - Convergent Matrices - II
- Lecture 35 - Stability of non linear system
- Lecture 36 - Condition number of a matrix: Elementary Properties
- Lecture 37 - Sensitivity Analysis - I
- Lecture 38 - Sensitivity Analysis - II
- Lecture 39 - Residual Theorem
- Lecture 40 - Nearness to Singularity
- Lecture 41 - Estimation of the Condition Number
- Lecture 42 - Singular value decomposition of a matrix - I
- Lecture 43 - Singular value decomposition of a matrix - II
- Lecture 44 - Orthonormal Projections
- Lecture 45 - Algebraic and geometric properties of SVD
- Lecture 46 - SVD and their applications
- Lecture 47 - Perturbation theorem for singular values
- Lecture 48 - Outer product expansion of a matrix
- Lecture 49 - Least square solutions - I
- Lecture 50 - Least square solutions - II
- Lecture 51 - Householder matrices
- Lecture 52 - Householder matrices and their applications
- Lecture 53 - Householder QR factorization - I
- Lecture 54 - Householder QR factorization - II
- Lecture 55 - Basic theorems on eigenvalues and QR method
- Lecture 56 - Power Method
- Lecture 57 - Rate of Convergence of Power Method
- Lecture 58 - Applications of Power Method with Shift
- Lecture 59 - Jacobi Method - I
- Lecture 60 - Jacobi Method - II

Lecture 1 - Introduction to Numerical solutions

Lecture 2 - Numerical Solution of ODE

Lecture 3 - Numerical solution of PDE

Lecture 4 - Finite difference approximation

Lecture 5 - Polynomial fitting and one-sided approximation

Lecture 6 - Solution of parabolic equation

Lecture 7 - Implicit and C-N scheme for solving 1D parabolic equation

Lecture 8 - Stability analysis of Explicit scheme for solving parabolic equation

Lecture 9 - Stability of Crank-Nicolson's scheme

Lecture 10 - Approximation of derivative boundary conditions

Lecture 11 - Solution of two-dimensional parabolic equation

Lecture 12 - Solution of 2D parabolic equation using ADI scheme

Lecture 13 - Solution of Elliptic Equation

Lecture 14 - Solution of Elliptic equation using SOR method

Lecture 15 - Solution of Elliptic equation using ADI scheme

Lecture 16 - Solution of Hyperbolic equation

Lecture 17 - Stability analysis for Hyperbolic equations

Lecture 18 - Characteristics of PDE

Lecture 19 - Lax-Wendroff's method

Lecture 20 - Wendroff's method

Lecture 1 - Functions of several variables

Lecture 2 - Limits for multivariable functions - I

Lecture 3 - Limits for multivariable functions - II

Lecture 4 - Continuity of multivariable functions

Lecture 5 - Partial Derivatives - I

Lecture 6 - Partial Derivatives - II

Lecture 7 - Differentiability - I

Lecture 8 - Differentiability - II

Lecture 9 - Chain rule - I

Lecture 10 - Chain rule - II

Lecture 11 - Change of variables

Lecture 12 - Euler's theorem for homogeneous functions

Lecture 13 - Tangent planes and Normal lines

Lecture 14 - Extreme values - I

Lecture 15 - Extreme values - II

Lecture 16 - Lagrange multipliers

Lecture 17 - Taylor's theorem

Lecture 18 - Error approximation

Lecture 19 - Polar-curves

Lecture 20 - Multiple Integrals

Lecture 21 - Change Of Order Of Integration

Lecture 22 - Change of Variables in Multiple Integral

Lecture 23 - Introduction to Gamma Function

Lecture 24 - Introduction to Beta Function

Lecture 25 - Properties of Beta and Gamma Functions - I

Lecture 26 - Properties of Beta and Gamma Functions - II

Lecture 27 - Dirichlet's Integral

Lecture 28 - Applications of Multiple Integrals

Lecture 29 - Vector Differentiation

Lecture 30 - Gradient of a Scalar Field and Directional Derivative

Lecture 31 - Normal Vector and Potential field

[Lecture 32 - Gradient \(Identities\), Divergence and Curl \(Identities\)](#)

[Lecture 33 - Some Identities on Divergence and Curl](#)

[Lecture 34 - Line Integral \(I\)](#)

[Lecture 35 - Applications of Line Integrals](#)

[Lecture 36 - Green's Theorem](#)

[Lecture 37 - Surface Area](#)

[Lecture 38 - Surface Integral](#)

[Lecture 39 - Divergence Theorem of Gauss](#)

[Lecture 40 - Stoke's Theorem](#)

- Lecture 1 - Introduction to differential equations - I
- Lecture 2 - Introduction to differential equations - II
- Lecture 3 - Existence and uniqueness of solutions of differential equations - I
- Lecture 4 - Existence and uniqueness of solutions of differential equations - II
- Lecture 5 - Existence and uniqueness of solutions of differential equations - III
- Lecture 6 - Existence and uniqueness of solutions of a system of differential equations
- Lecture 7 - Linear System
- Lecture 8 - Properties of Homogeneous Systems
- Lecture 9 - Solution of Homogeneous Linear System with Constant Coefficients - I
- Lecture 10 - Solution of Homogeneous Linear System with Constant Coefficients - II
- Lecture 11 - Solution of Homogeneous Linear System with Constant Coefficients - III
- Lecture 12 - Solution of Non-Homogeneous Linear System with Constant Coefficients
- Lecture 13 - Power Series
- Lecture 14 - Uniform Convergence of Power Series
- Lecture 15 - Power Series Solution of Second Order Homogeneous Equations
- Lecture 16 - Regular singular points - I
- Lecture 17 - Regular singular points - II
- Lecture 18 - Regular singular points - III
- Lecture 19 - Regular singular points - IV
- Lecture 20 - Regular singular points - V
- Lecture 21 - Critical points
- Lecture 22 - Stability of Linear Systems - I
- Lecture 23 - Stability of Linear Systems - II
- Lecture 24 - Stability of Linear Systems - III
- Lecture 25 - Critical Points and Paths of Non-linear Systems
- Lecture 26 - Boundary value problems for second order differential equations
- Lecture 27 - Self - adjoint Forms
- Lecture 28 - Sturm - Liouville problem and its properties
- Lecture 29 - Sturm - Liouville problem and its applications
- Lecture 30 - Green's function and its applications - I
- Lecture 31 - Green's function and its applications - II

- Lecture 32 - Origins and Classification of First Order PDE
- Lecture 33 - Initial Value Problem for Quasi-linear First Order Equations
- Lecture 34 - Existence and Uniqueness of Solutions
- Lecture 35 - Surfaces orthogonal to a given system of surfaces
- Lecture 36 - Nonlinear PDE of first order
- Lecture 37 - Cauchy method of characteristics - I
- Lecture 38 - Cauchy method of characteristics - II
- Lecture 39 - Compatible systems of first order equations
- Lecture 40 - Charpitâ€™s method - I
- Lecture 41 - Charpitâ€™s method - II
- Lecture 42 - Second Order PDE with Variable Coefficients
- Lecture 43 - Classification and Canonical Form of Second Order PDE - I
- Lecture 44 - Classification and Canonical Form of Second Order PDE - II
- Lecture 45 - Classification and Characteristic Curves of Second Order PDEs
- Lecture 46 - Review of Integral Transforms - I
- Lecture 47 - Review of Integral Transforms - II
- Lecture 48 - Review of Integral Transforms - II
- Lecture 49 - Review of Integral Transforms - III
- Lecture 50 - Laplace Equation - I
- Lecture 51 - Laplace Equation - II
- Lecture 52 - Laplace and Poisson Equations
- Lecture 53 - One dimensional wave equation and its solution - I
- Lecture 54 - One dimensional wave equation and its solution - II
- Lecture 55 - One dimensional wave equation and its solution - III
- Lecture 56 - Two dimensional wave equation and its solution - I
- Lecture 57 - Solution of non-homogeneous wave equation
- Lecture 58 - Solution of homogeneous diffusion equation - I
- Lecture 59 - Solution of homogeneous diffusion equation - II
- Lecture 60 - Duhamelâ€™s principle

Lecture 1 - Elementary row operations

Lecture 2 - Echelon form of a matrix

Lecture 3 - Rank of a matrix

Lecture 4 - System of Linear Equations - I

Lecture 5 - System of Linear Equations - II

Lecture 6 - Introduction to Vector Spaces

Lecture 7 - Subspaces

Lecture 8 - Basis and Dimension

Lecture 9 - Linear Transformations

Lecture 10 - Rank and Nullity

Lecture 11 - Inverse of a Linear Transformation

Lecture 12 - Matrix Associated with a LT

Lecture 13 - Eigenvalues and Eigenvectors

Lecture 14 - Cayley-Hamilton Theorem and Minimal Polynomial

Lecture 15 - Diagonalization

Lecture 16 - Special Matrices

Lecture 17 - More on Special Matrices and Gerschgorin Theorem

Lecture 18 - Inner Product Spaces

Lecture 19 - Vector and Matrix Norms

Lecture 20 - Gram Schmidt Process

Lecture 21 - Normal Matrices

Lecture 22 - Positive Definite Matrices

Lecture 23 - Positive Definite and Quadratic Forms

Lecture 24 - Gram Matrix and Minimization of Quadratic Forms

Lecture 25 - Generalized Eigenvectors and Jordan Canonical Form

Lecture 26 - Evaluation of Matrix Functions

Lecture 27 - Least Square Approximation

Lecture 28 - Singular Value Decomposition

Lecture 29 - Pseudo-Inverse and SVD

Lecture 30 - Introduction to Ill-Conditioned Systems

Lecture 31 - Regularization of Ill-Conditioned Systems

[Lecture 32 - Linear Systems: Iterative Methods - I](#)

[Lecture 33 - Linear Systems: Iterative Methods - II](#)

[Lecture 34 - Non-Stationary Iterative Methods: Steepest Descent - I](#)

[Lecture 35 - Non-Stationary Iterative Methods: Steepest Descent - II](#)

[Lecture 36 - Krylov Subspace Iterative Methods \(Conjugate Gradient Method\)](#)

[Lecture 37 - Krylov Subspace Iterative Methods \(CG and Pre-Conditioning\)](#)

[Lecture 38 - Introduction to Positive Matrices](#)

[Lecture 39 - Positive Matrices, Positive Eigenpair, Perron Root and vector, Example](#)

[Lecture 40 - Polar Decomposition](#)

- Lecture 1 - Introduction to Mathematical Modeling
- Lecture 2 - Discrete Time Linear Models in Population Dynamics - I
- Lecture 3 - Discrete Time Linear Models in Population Dynamics - II
- Lecture 4 - Discrete Time Linear Age Structured Models
- Lecture 5 - Numerical Methods to Compute Eigen Values
- Lecture 6 - Discrete Time Non-Linear Models in Population Dynamics - II
- Lecture 7 - Analysis on Logistic Difference Equation
- Lecture 8 - Classifications of Bifurcation
- Lecture 9 - Discrete Time Non - Linear Models in Population Dynamics - II
- Lecture 10 - Discrete Time Prey - Predator Model
- Lecture 11 - Introduction to Continuous Time Models
- Lecture 12 - Solution of First Order First Degree Differential Equations
- Lecture 13 - Continuous Time Models in Population Dynamics - I
- Lecture 14 - Continuous Time Models in Population Dynamics - II
- Lecture 15 - Stability and Linearization of System of Ordinary Differential Equations
- Lecture 16 - Continuous Time Single Species Models
- Lecture 17 - Qualitative Solution of Differential Equations - Phase Diagrams - I
- Lecture 18 - Qualitative Solution of Differential Equations - Phase Diagrams - II
- Lecture 19 - Continuous Time Lotka - Volterra Competition Model
- Lecture 20 - Continuous Time Prey - Predator Model

- Lecture 1 - Formulation of Dynamical Systems - I
- Lecture 2 - Formulation of Dynamical Systems - II
- Lecture 3 - Existence and Uniqueness Theorem - I
- Lecture 4 - Existence and Uniqueness Theorem - II
- Lecture 5 - Linear Systems - I
- Lecture 6 - Linear Systems - II
- Lecture 7 - Solutions of Linear Systems - I
- Lecture 8 - Solutions of Linear Systems - II
- Lecture 9 - Solutions of Linear Systems - III
- Lecture 10 - Fundamental Matrix - I
- Lecture 11 - Fundamental Matrix - II
- Lecture 12 - Fundamental Matrix for Non-Autonomous systems
- Lecture 13 - Solutions of Non-Homogeneous Systems
- Lecture 14 - Stability of Systems: Equilibrium Points
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