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Lecture Summaries for Differential Equations M53a

Lecture 01: An introduction to the very basic definitions and terminology of differential equations, as well as a discussion of central issues and objectives for the course.

Lecture 02: Solving first order linear differential equations and initial value problems using integrating factors.

Lecture 03: Solving separable equations.

Lecture 04: The Existence and Uniqueness Theorem for solving general first order linear equations.

Lecture 05: Applications of first order ODEs involving continuous compounding, and population dynamics using the logistic equation.

Lecture 06: Solving the logistic equation, and an application of first order ODEs to a problem of physics.

Lecture 07: Solving exact equations.

Lecture 08: Sketching a proof of the Existence and Uniqueness Theorem for first order ODEs.

Lecture 09: An introduction to difference equations and their solutions, focusing on first order linear difference equations.

Lecture 10: An application of first order linear difference equations, as well as a brief discussion of non-linear difference equations, their solutions, and stairstep diagrams.

Lecture 11: An introduction to second order ODEs and initial value problems, and a discussion of solutions to second order homogeneous constant coefficient equations.

Lecture 12: A discussion of existence and uniqueness results for second order linear ODEs, and of fundamental sets of solutions and the importance of the Wronskian of solutions.

Lecture 13: A discussion of the structure of the set of solutions to a linear homogeneous ODE from a linear algebra perspective; concepts such as linear independence, span, and basis are used to better understand fundamental sets of solutions.

Lecture 14: Solving ODEs with characteristic equation having non-real complex roots.

Lecture 15: Solving ODEs with characteristic equation having repeated roots.

Lecture 16: Solving second order linear non-homogeneous equations using the method of undetermined coefficients.

Lecture 17: Solving second order linear non-homogeneous equations using the method of variation of parameters.

Lecture 18: A discussion of the structure of solution sets to higher order linear equations, the basic Existence and Uniqueness Theorem, and a generalization of the Wronskian.

Lecture 19: Solving higher order constant coefficient homogeneous equations.

Lecture 20: Solving higher order non-homogeneous equations using the method of undetermined coefficients.

Lecture 21: Solving higher order non-homogeneous equations using the method of variation of parameters.

Lecture 22: A review of the most fundamental properties of power series.

Lecture 23: Solving differential equations and initial value problems using power series.

Lecture 24: An example of how to use power series to solve non-constant coefficient ODEs, and a discussion of the basic theorem underlying the use of power series to solve ODEs.

Lecture 25: A review of improper integration and an introduction to the Laplace transform.

Lecture 26: A discussion of the main properties of the Laplace transform which make it useful for solving initial value problems.

Lecture 27: A discussion of how the Laplace transform and its inverse act on unit step functions, exponentials, and products of these functions with others.

Lecture 28: An introduction to the convolution of two functions, and an examination of how the Laplace transform acts on such a convolution.

Lecture 29: An introduction to systems of equations and the basic existence and uniqueness result for the corresponding initial value problems.

Lecture 30: An introduction to vector function notation, and a discussion of the structure of solution sets to homogeneous systems and the importance of the Wronskian.

Lecture 31: Solving constant coefficient linear homogeneous systems using eigenvalues and eigenvectors.

Lecture 32: Solving constant coefficient linear homogeneous systems in the case where an eigenvalue is complex.

Lecture 33: Solving constant coefficient linear homogeneous systems in the case where there is a repeated eigenvalue.

Lecture 34: Viewing solutions to linear homogeneous systems in terms of fundamental matrices and the exponential of a matrix.

Lecture 35: Solving non-homogeneous systems using diagonalization and variation of parameters.