

IODE - Topics Covered / Emphasized

Unit 1 - Qualitative and Graphical Approaches

- Modeling (Population)
- What exactly is a differential equation and its solution?
- Slope Fields

Unit 2 - A numerical approach

- Modelling (Population)
- Euler's method

Unit 3 - An analytic approach

- Understanding solutions as continually changing slopes in Euler's method
- Separation of variables
- When can new solutions be obtained by shifting old ones?

Unit 4 - Linear Differential Equations

- Modeling (Compartmental Analysis (Brine tanks))
- Integrating Factors (developed as the "Reverse Product Rule")
- Numerical methods as a means to check analytic solutions

Unit 5 - Uniqueness of Solutions

- Modeling (Understanding solution curves in context)
- The Uniqueness Theorem

Unit 6 - Autonomous Differential Equations

- Phase lines

Unit 7 - Modeling with Autonomous Differential Equations

- Modeling (Newton's Law of Cooling)
- Building phase lines from graphs of dx/dt vs x

Unit 8 - The Effect of Varying a Parameter in Autonomous Differential Equations

- Modeling (Population and harvesting)
- Bifurcation theory: saddle node and transcritical

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Unit 9 - Introduction to Systems

- Modeling / nonlinear systems (Lotka-Volterra)
- Euler's method for systems
- 3d structures of solutions
- Phase planes
- Construction of vector fields
- Nullclines

Unit 10 - Spring Mass and Linear Systems

- Modelling (springs)
- Conversion from second order equations to first order systems
- Straight line solutions (i.e. solutions living on eigenvectors)

Unit 11 - Damped and Undamped Linear Systems

- Complex eigenvalues

Unit 12 - Eigentheory applied to Linear Systems

- Using eigenvalues to find solutions to linear systems

Unit 13 - Second order linear DEs

- Method of undetermined coefficients

Unit 14 - Nonlinear systems

- Modelling (pendulum)
- Linear stability analysis

Other considerations

Included as homework:

- Runge-Kutta (Unit 4, HW 6)
- Careful consideration of superposition principle (Unit 11, HW 7)
- Variation of Parameters (Unit 13, HW 9)

Topics not included:

- Generalized Eigenvectors
- Series solutions
- Laplace transforms
- Explicit MATLAB questions