Ph.D. Comprehensive Study Guide for Mathematics and Numerical Analysis

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[1] Differential Equations (MECH 202/203)
Textbook (Creative Commons): Elementary Differential Equations by William F. Trench, 2013
https://digitalcommons.trinity.edu/mono/8/

1.1 Applications Leading to Differential Equations
1.2 First Order Equations

2.1 Linear First Order Equations
2.2 Separable Equations
2.6 Integrating Factors

4.1 Growth and Decay
4.2 Cooling and Mixing
4.3 Elementary Mechanics (Note: only metric units required)

5.1 Homogeneous Linear Equations
5.2 Constant Coefficient Homogeneous Equations
5.3 Non-homogeneous Linear Equations

6.1 Spring Problems I

10.1 Introduction to Systems of Differential Equations
10.2 Linear Systems of Differential Equations
10.4 Constant Coefficient Homogeneous Systems I
(including interpreting solutions implied by positive, negative and complex eigenvalues and eigenvectors)

[2] Numerical Analysis (MECH 202/203)
Textbook (Creative Commons): An Intuitive Guide to Numerical Methods, by Brian Heinold, 2013
https://www.brianheinold.net/books.html or
https://www.brianheinold.net/numerical/An_Intuitive_Guide_to_Numerical_Methods_Heinold.pdf

1.1 What Numerical Methods is about
1.1 Floating-point arithmetic

2.1 Bisection method
2.3 Newton's method
2.5 Secant method

3 Interpolation Chapter opening materials - for polynomial interpolation
3.6 Piecewise linear interpolation
3.7 Cubic spline interpolation
3.9 Summary of interpolation (and difference from regression/function fitting)

4.1 Basics of numerical differentiation
4.2 Centered difference formula
4.6 Summary of numerical differentiation

5.1 Newton-Cotes formulas

6.1 Euler’s method
6.2 Explicit trapezoid method
6.3 The midpoint method
6.4 Runge-Kutta