

**University Of Pennsylvania**  
**Department of Mechanical Engineering and Applied Mechanics**  
**ENM510 - Foundations of Engineering Mathematics I (Course Outline)**

**Instructor: Dr. Michael A. Carchidi**

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- Textbooks:**
- 1.) *Boundary Value Problems* by David L. Powers  
(5<sup>th</sup> Edition, Elsevier/Academic Press Publishers, @2006).
  - (Required)**
  - (Recommended)** 2.) *Elementary Linear Algebra, Applications Version* by Anton & Rorres (8<sup>th</sup> Edition, Wiley Publishers, @2000).  
This to be used as a guide if you need to review your undergraduate coursework.
  - 3.) *Class Notes* by Michael A. Carchidi
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<b>Week</b>	<b>Topics Covered</b>
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**Linear Vector Spaces**

- 1 Introduction to Boundary-Value, Initial-Value Problems, A Heat-Equation Example, The Methods Of Separation of Variables

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- 2 Linear Vector Spaces, Subspaces, Spanning Sets, Linear Independence, Basis, Dimensions and Coordinates Vectors

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- 3 Inner Product Spaces, Abstract Angles, Distances, and Orthogonality, Fourier Series

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- 4 Orthogonality and the Gram-Schmidt Process

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- 5 Function Spaces, Linear Operators and Eigenspaces

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**Week**

**Topics Covered**

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**Ordinary Differential Equations and Boundary-Value Problems**

6 Second-Order Differential Equations, Special Substitutions, The Theory of Linear Equations, Constant Coefficients, Substitutions and Table-Lookup Methods, Variations of Parameters

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7 The Initial-Value Problem, One-Sided Green's Functions, The Boundary-Value Problem and Two-Sided Green's Functions, Boundary-Value, Eigenvalue-Eigenfunction Problems

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8 Sturm-Liouville Problems, Inner Products and Orthogonality, Eigenfunction Representations, Fourier Series

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9 Power-Series Methods, Legendre's Equation, The Method of Frobenius, Bessel's Equation, Bessel Series, Legendre Series, Properties of the Bessel and Legendre Functions

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**Partial Differential Equations and Boundary-Value, Initial-Value Problems**

10 The Method of Separation of Variables Revisited, The one-dimensional Heat Equation, Steady-State and Transient Solutions

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11 The one-dimensional Wave Equation, The Potential Equation, The Multidimensional Heat and Wave Equation, Problems in Spherical and Cylindrical Coordinates

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12 The Method of Characteristics: Quasi-Linear Equations of First Order, Linear and

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13 The Method of Characteristics: Quasi-Linear Equations of Second Order, Constant Coefficients, The Treatment of Initial and Boundary Conditions

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14 Laplace and Fourier Transform Methods for Solving Boundary-Value, Initial-Value Problems

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