

Fall 2009

ME 550. FOUNDATIONS OF ENGINEERING SYSTEMS ANALYSIS
(Schedule No. 268543)

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Web Page Address: http://www.mne.psu.edu/ray/graduate_courses.html

Office Hours: By appointment

Lecture Class Time and Location: MWF 11:15 AM to 12:05 PM 206 Hammond

Recitation Class Time and Location: T 5:45 PM to 7:00 PM 214 Reber

Instructional Objectives:

This 3-credit course is offered at the first year graduate level, and it provides a systems-theoretic background for a variety of graduate courses in the disciplines of engineering and science. Various application examples are developed in this course by using the vector space approach.

Course Outline:

Review of the fundamentals of real and complex analysis. Concepts of finite-dimensional vector spaces from both algebraic and topological points of view. Introduction to infinite-dimensional vector spaces and function spaces along with the notion of completeness. Normed linear spaces, inner product spaces, orthogonal projections and orthogonal polynomials with examples from ℓ_p , L_p and H_p spaces. Fourier theory and sampling for signal decomposition. Notions of separable spaces and complete orthonormal sets, and their applications to approximation techniques for solution of problems in engineering and science. Introduction to linear transformations, operators, functionals, and functions of operators.

Isomorphism between two spaces, and its significance to solution of similar problems in different applications of engineering and science. Duality and adjoint spaces. Concepts of reciprocal basis. Riesz-Frechet theorem, Hahn-Banach theorem, and their applications to solution of optimization problems. Different classes of continuous linear operators with emphasis on compact operators. Spectral analysis of infinite-dimensional operators.

Examples to show relevance and importance of the system-theoretic approach to solutions of problems such as finite-dimensional approximation of linear partial differential equations, sampling of continuous signals, optimal control and optimal estimation, and linear programming. Analysis of problems in engineering and science belonging to the class of Sturm-Liouville systems and Green's functions.

Prerequisite: Math 436 or an equivalent course in Linear Algebra

Text Book: A. W. Naylor and G.R. Sell, [*Linear Operator Theory in Engineering and Science*](#), Springer-Verlag, New York, 1982 [QA1.A647 v.40]

Reference Books:

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| S. Axler, <i>Linear Algebra Done Right</i> , 2nd ed., Springer, New York, 1997 | [QA184.A96 1997] |
| R. Bartle, <i>The Elements of Integration and Lebesgue Measure</i> , Wiley, 1995 | [QA312.B3 1995] |
| E. Kreyszig, <i>Introductory Functional Analysis</i> , Wiley, 1989 | [QA320.K74 1989] |
| D.G. Luenberger, <i>Optimization by Vector Space Methods</i> , Wiley, 1969 | [QA402.5.L8] |
| J.R. Munkres, <i>Topology</i> , 2nd ed., Prentice Hall, 2000 | [QA611.M82 2000] |
| H.L. Royden, <i>Real Analysis</i> , 3 rd ed., McMillan, New York, 1988 | [QA331.5.R6 1988] |
| W. Rudin, <i>Principles of Mathematical Analysis</i> , McGraw Hill, 1976 | [QA300.R8 1976] |
| W. Rudin, <i>Real and Complex Analysis</i> , 3 rd ed., McGraw Hill, 1987 | [QA300.R82 1987] |
| G. Strang, <i>Linear Algebra and Its Applications</i> , 4th ed., Thomson, 2006 | [QA184.S8 2006] |
| E.B. Vinberg, <i>A Course in Algebra</i> , American Mathematical Society, 2003 | [QA154.3.V56 2003] |