

# MAE 143A

## Signals and Systems

**Designation:** Required course

**Catalog Data:**

MAE 143A Signals and Systems (4)

First-order vector ordinary differential equations, concepts of state, input and output. Linearity and linearization concepts introduced and solutions described. Laplace and Fourier transforms are defined for signals. Transfer functions and frequency responses are introduced for systems. Spectra and filtering are introduced for deterministic signals, probability and statistics of random signals and their treatment.

**Prerequisites:** Admission to the engineering major and grades of C- or better in Math 20D, 20E and 20F.

**Textbook, Required Materials:** Franklin, Powell and Emami-Naeini, Feedback Control of Dynamic Systems, 5<sup>th</sup> edition, Prentice Hall 2006.

**Prerequisites by Topic:** Differential equations, vector calculus and linear algebra.

**Class/Laboratory Schedule:** 4 lecture hours per week

**Course topics:**

1. Dynamical modeling and ordinary differential equations
2. Linearization and linear systems
3. Time domain properties of solutions, convolution.
4. Laplace transforms, transfer functions
5. Fourier transforms, frequency response, spectra
6. Sampling and discrete signals, aliasing
7. z-transform, discrete Fourier transform
8. Probability and statistics of random signals
9. Elements of filtering
10. Computational evaluation using Matlab

**Course objectives:**

(Numbers in parenthesis refer to the specific MAE Program Outcomes.)

Objective 1: To teach students the basic principles of physical signals and of the systems which modify or manipulate them (1a, 3c, 11k).

Objective 2: To train students to formulate and to solve Engineering problems using representations and techniques of both time and frequency domain (1a, 3c, 5e).

Objective 3: To introduce the students to the concepts and some techniques of the analysis of random signals using probability and statistics (1a, 5e, 11k).

**Methods of evaluation:**

1. Homework and computer exercises will be regularly collected and graded.
2. Examinations.

**Performance criteria:**

(Numbers in parentheses refer to the methods of evaluation used to assess student performance.)

**Objective 1**

1.1 Students will demonstrate understanding of the distinction between the representation of a signal in transform domain and the systems which operate upon them (1,2).

1.2 Students will demonstrate the ability to use transform domain techniques to solve for signal properties via filtering (1,2).

**Objective 2**

2.1 Students will be able to demonstrate, using standard computational tools, the ability to compute, display and interpret modified signals and system properties connected with realistic Engineering problems such as low-pass filtering and downsampling (1,2).

2.2 Students will formulate criteria for the solution of industrial signal conditioning problems and then develop solutions (1,2).

**Objective 3**

3.1 Students will demonstrate understanding of the concepts of correlation, independence and covariance of pairs of signals (1,2).

3.2 Students will demonstrate an understanding of the interpretation of spectra of random signals and of the effects of filtering such signals (1,2).

**Contribution of Course to Professional Component:**

Engineering Science

**Syllabus prepared by:** Robert Bitmead, March 2000.

**Revised:** Miroslav Krstic, April 2008 via Teaching Work Group meeting.