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| **Course alpha, number, title** | ME 391 Mechanical Engineering Analysis |
| **Required or elective** | Required |
| **Course (catalog) description** | Analytical and numerical methods for the modeling and analysis of mechanical engineering systems. Applications to vibrating elements, heat transfer, linear springs, and coupled spring-mass systems. |
| **Prerequisite(s)** | (MTH 235 or MTH 255H or LBS 220) |
| **Textbook(s) and/or other required material** | *Advanced Engineering Mathematics*, D. Zill and M. Cullen, Jones & Bartlett, 2nd ed., 2000.<br>*Advanced Engineering Mathematics*, 2nd Edition, by Michael D. Greenberg (Prentice-Hall). |
| **Class/Lab schedule:** | Total Credits: 3 *Lecture/Laboratory/Discussion Hours: 3/0/0* |
| **Topics covered** | a. Linear Algebra<br>b. Ordinary Differential Eqns.<br>c. Partial Differential Equations<br>d. Coupled Spring-Mass Systems<br>e. Vibrating Strings using separation of variables<br>f. Heat Conduction using separation of variables.<br>g. Laplace Transforms<br>h. Numerical Integration<br>i. Periodic Forcing Functions<br>j. Vector Calculus, including divergence and curl and the directional derivative. |

**Course learning objectives**

1. Ordinary differential equation formulations
   a) Students are able to formulate certain types of physical problems suitably.
   b) Students are able to determine types of ODEs and to select an appropriate solution method.
   c) Students are able to apply solution methods, such as transformations and Laplace transforms, to generate solutions.
   d) Students are able to interpret solutions in terms of the problem physics.

2. Taylor Series methods
   a. Students are able to state a Taylor Series definition in generic terms.
   b. Students are able to generate Taylor Series solutions to selected problems.
   a. Students are able to interpret their solutions using a Taylor series.

3. Laplace Transforms
   a. Students are able to write the generic definition of a Laplace Transform.
   b. Students are able to compute the Laplace Transforms of selected functions, both by direct integration and by relational operators.
   c. Students are able to solve low-order linear ordinary differential equations with constant coefficients and limited types of forcing, using the Laplace Transform method and table lookup.

4. Matrices
   a. Students are able to define certain properties of matrices and state which matrix operations are permissible.
   b. Students are able to carry out selected matrix operations.
   c. Students are able to use matrix methods to solve low-order linear algebraic systems.

5. Fourier Series
   a. Students are able to state a Fourier Series definition in generic terms.
   b. Students are able to formulate problems in terms of Fourier Series appropriately.
   c. Students are able to generate Fourier Series solutions to selected problems.
   d. Students are able to interpret their solutions.

6. Partial differential equations
   a. Students are able to recognize PDE formulation of certain physical problem types.
   b. Students are able to identify simple types of PDEs.
   c. Students are able to identify well-posed PDE formulations for certain types of physical problems.
   d. Students are able to apply appropriate solution methods for selected formulations.
   e. Students are able to interpret solutions in terms of problem physics.

**Relationship of course to ME program outcomes**

The following measurement standard is used to evaluate the relationship between the course outcomes and the educational-program outcomes:
3 = Strong Emphasis, 2 = Some Emphasis, 1 = Little or No Emphasis.

(a) an ability to apply knowledge of mathematics, science, and engineering—3
(b) an ability to design and conduct experiments, as well as to analyze and interpret data—1
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability—1
(d) an ability to function on multidisciplinary teams—1
(e) an ability to identify, formulate, and solve engineering problems—1
(f) an understanding of professional and ethical responsibility—1
(g) an ability to communicate effectively—1
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context —1
(i) a recognition of the need for and the ability to engage in life-long learning—1
(j) a knowledge of contemporary issues—1
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice—2
(l) application of advanced mathematics—3
(m) design, build, and test in mechanical systems area—1
(n) design, build, and test in thermal/fluids area—1
(o) capstone design experience—1

**Contribution to professional component:**

33% Engineering Science 0% Engineering Design 67% Math and Basic Science

**Person(s) who prepared this description**

Indrek Wichman and Maureen Blazer-Adams

**Date of Preparation**

December 10, 2009