**AE 3530 - System Dynamics and Vibration**

**Hours:** 3-0-3

**Catalog Description (25 words or fewer):**

Modeling and analysis of lumped- and distributed-parameter systems, free and forced vibration in mechanical systems, free vibration in structural systems.

**Prerequisites:**

AE2220

Math 2403

**TEXTBOOKS:**

1. Ogata, K., "System Dynamics," Prentice Hall.
2. Hodges and Pierce: Introduction to Structural Dynamics and Aeroelasticity, Cambridge University.

**Course Objectives:** Provide students with a foundational understanding of dynamic modeling and analysis of both lumped parameter (mechanical) systems and distributed parameter (structural) systems, and free and forced vibration response of those systems.

**Learning Outcomes:**

Students will gain a mastery level of:

1) Modeling of Physical Systems

2) Distributed parameter systems versus lumped parameters

3) Response of 1st and 2nd Order Dynamic Systems

4) Mode shapes, natural frequencies and expansion theorem (modal superposition)

Students will gain basic capability or understand of:

5) Response of Higher Order Dynamic Systems

6) Free Vibrations (free and forced)

**topical outline: Hrs**

1. Introduction 1
2. Mathematical background for system analysis 5

Complex numbers, variables and functions

Laplace transformation

Inverse Laplace Transformation

Solution of linear, time invariant differential equations

Linearization

1. Modeling of Mechanical Systems 6

Mechanical elements

Modeling of mechanical systems

Work, Energy, and Power

1. Linear System Analysis in the Time Domain 5

Transfer functions

Transient response of first and second order systems

Impulse response

1. Linear System Analysis in the Frequency Domain 5

Frequency response of first and second order systems

Bode diagrams

Vibration isolation

Vibration absorbers

1. Modeling of Dynamic Systems in State Space 5

State-space representation

Eigenvalues and eigenvectors

Solution of state equations

1. Free vibrations of a string 4

Distributed parameter systems

Natural frequencies

Mode shapes

1. Forced response 2

Transient response

Steady state response

1. Torsional vibrations of beams 3

1. Bending vibration of beams: free response 5

Mid Term Exam and Quizzes 3

Total 45