

ME 481
System Dynamics and Vibrations
(3 credit hours)

Objectives

1. Model real elements of mechanical and electrical systems
2. Analyze and predict dynamic behavior of mechanical and electrical systems
3. Design simple mechanical and electrical systems to meet specified dynamic performance criteria
4. Model multi-degree of freedom vibration systems
5. Demonstrate team work and the ability to use computer simulation and productivity tools in a project setting

Prerequisites

ME 250, Numerical Methods in Mechanical Engineering
 Elec Eng 300, Electrical Circuits

Before taking this class, the students should specifically know:

1. How to solve ordinary differential equations
2. Basic electrical elements (resistor, inductor, capacitor)
3. How to analyse basic electrical circuits (Kirchoff laws, mesh analysis)
4. How to write simple programs in Matlab

Topics

1. Modeling of Electrical Elements and Systems
2. Operational Amplifiers
3. Modeling Mechanical Elements and Systems
4. Linearization of Nonlinear Elements
5. Solution Methods for Linear Differential Equations
6. Transfer Function Formulation and Analysis
7. First Order System Parameters, Step and Frequency Responses
8. Second Order System Parameters, Step and Frequency Responses
9. Free and Forced Vibrations
10. Case Studies in Mechanical and Electrical Systems

Basis of Grading

1. Midterm
2. Final
3. Homework
4. Project

Concepts and Techniques

1. Solving linear ordinary differential equations
2. Linearization of differential equations
3. Laplace Transforms
4. Inverse Laplace transforms
5. Basic Block diagrams
6. Transfer Function analysis

Dynamic Response

1. Step response of first and second order systems
2. Ramp response of first and second order systems
3. Frequency response of first and second order systems (single frequency input)
4. Simulation of first, second, and higher order systems using Simulink

Electrical Systems

1. Electrical elements
2. Operational amplifiers
3. Write differential equations of basic electrical circuits
4. Modeling of first order electrical systems
5. Modeling of second order electrical systems

Mechanical Systems

1. Mechanical elements
2. Write differential equations from physical systems
3. Write differential equations from schematic diagrams
4. Write differential equations for 1 and 2 degree of freedom systems
5. Electro-mechanical analogies/impedance

Advanced Mechanical Systems

1. Model n - degree of freedom systems
2. Basic vibration isolation
3. Rotational unbalance
4. Write differential equations for 1, 2, and n degree of freedom systems
5. Basic understanding of natural frequencies and mode shapes

Project

1. Analyse a mechanical system
2. Satisfy dynamic design criteria