CIV 432 - Vibration Mechanics

Current Catalog Description: Analysis of the response of structures and structural components to dynamic loads such as vibrating forces, and foundation excitations. Response of discrete (simplified) systems, both of the single-degree-of-freedom and multi-degree-of-freedom type. Frequency response functions. Numerical methods for integrating the equations of motion. Response of continuous systems with distributed mass and flexibility.

Prerequisite: AMS 361 or MAT 303 or MAT 305; MEC 262; CIV 310

Corequisite: None

Textbooks and/or Other Required Material: None

This course is: Not Required;
Technical Elective Option

Topics Covered:

1. Introduction on single degree-of-freedom (SDOF) systems
    a. Single DOF systems - Free vibrations
    b. SDOF systems - Free vibrations with damping
    c. SDOF systems - Harmonic excitations
    d. SDOF systems - Frequency response functions
    e. SDOF systems - Base excitation & How vibration-measuring devices work
    f. SDOF systems - Other periodic excitations and Fourier transform
    g. SDOF systems - Non-periodic excitations
2. MATLAB recap/tutorial with emphasis on SDOF systems
    a. SDOF systems - Non-periodic excitations and numerical integration
    b. Single DOF systems - Numerical integration & Earthquake response
3. Introduction on multi degree-of-freedom (MDOF) systems
    a. MDOF systems - Free Vibrations & Modal Analysis
    b. MDOF systems - Free Vibrations with damping
    c. MDOF systems - Response to Harmonic loads
    d. MDOF systems - Response to Harmonic loads with damping
    e. MDOF systems - The tuned mass damper
4. Continuous systems
5. Continuous systems / Finite element methods for dynamic problems
6. Finite element methods for dynamic problems

Course Learning Objectives:

Understand the basic principles of free and damped vibrations of structural elements and systems
Compute the free and forced vibration response of single- degree- of- freedom (SDOF) systems, and understand their frequency response.
Compute the response of SDOF systems to arbitrary loads, both analytically and numerically
Implement some of these numerical schemes in MATLAB, and use MATLAB to visualize the response of dynamically-excited systems
Compute the free and forced vibration response of multi-degree-of- freedom (MDOF) systems, and understand their frequency response
Use a matrix formulation to analyze the vibration response of MDOF systems, and to determine their natural frequencies and mode shapes
Compute the dynamic response of continuous systems and, in particular, of simple structural elements such as beams and trusses.

Prepared by: Paolo Celli (2020)