UNICUSANO
ROME

Code: ING-IND/13 **Credits: 9**
Matter: Mechanical Vibrations
Main language of instruction: Italian
Other language of instruction: English

Teaching Staff

Head instructor
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Introduction
The course provides the fundamentals of free and forced vibration in mechanical systems and simple structural elements. Moreover, it provides the basis of measuring technique for vibrating and experimental modal analysis.

Objectives
Knowledge and understanding: At the end of the course, the student will know the mathematical formulation of both continuous and discrete vibrating systems. He will know the methods of measuring vibrations and identifying them. He will know the mathematical foundations of modal analysis, both numerical and experimental, and the fundamentals of analysis of both analogical and digital signals coming from vibration measuring instruments. Finally, the student will know the mathematical formulation suitable for dealing with both deterministic (harmonic, periodic, impulsive, etc.) and random forcing. Moreover, through the Etivity students will acquire the ability to formulate and solve the problems of vibration mechanics within the Octave software
Applying knowledge and understanding: At the end of the course, the student will be able to apply the acquired skills to the study of problems related to vibrations in the mechanical field: problems of structural resonance, problems of responses to harmonic, impulsive and random forces. will be able to choose and configure vibration measurement instruments for the dynamic characterization of mechanical systems. The Etivity provide for the application of theoretical knowledge to practical problems to be solved with the aid of calculation software (Octave).
Making judgements: At the end of the course, the student will have acquired the ability to identify the causes and propose effective remedies for vibratory problems of mechanical systems, he will also be able to choose the most appropriate instrumentation for the measurement and characterization of a mechanical system

Communication skills: At the end of the course, the student will have developed a correct scientific language that allows him to express in a clear and unambiguous way the technical knowledge acquired in the field of vibrations of mechanical systems. Moreover, he will have the ability to present the dynamic behavior of vibrating systems with appropriate calculation codes and graphs.
Learning skills: At the end of the course, the student will have the ability to apply the acquired knowledge to the resolution of unfamiliar problems that have as their object the vibrations of mechanical systems. Moreover, the student will be able to continue his studies (master and doctorate) on the themes of *cold mechanics*, both theoretical and experimental, having autonomy in consulting specialized textbooks

Competencies:
The student should be able solve simple problem on vibrating systems under various types of excitations (harmonic, periodic, impulse, step, random stationary). The student should be familiar with the concept of natural frequency and modes and with the modal analysis concepts. The student should acquire the fundamentals of the measurements technique for vibrating systems

Syllabus

1. *Vibration of One degree of freedom system*
    a. *theory*
    b. *time domain Vs frequency domain*
    c. *response of the system*
    d. *vibration isolation*
2. *N degrees of freedom systems.*
    a. *Free vibrations: eigenvalues, eigenvectors, orthogonality*
    b. *Forced vibration: modal analysis*
    c. *Damping models.*
3. *Vibrations in strings, rods, shafts and beams.*
    a. *Free vibrations: eigenvalues and modes.*
    b. *Forced vibration: modal analysis.*
4. *Measure of the dynamics of structures.*
    a. *Sensors, exciters, and measuremet chains*
    b. *Measure of the frequency response function*
    c. *Experimental modal analysis*
5. *Signals:*
    a. *Sampling and digital description of signals*
    b. *Discrete Fourier transform,*
    c. *Windowing .*
6. *Stochastic processes.*

a. *probability*
b. *probability distributions*
c. *time domain and frequency domain .*
d. *estimation of the frequency response function: coherency function*

7. *Random vibrations*
    a. *One degrees of freedom systems with random excitations*

Evaluation system and criteria

The exam consists in a written test aimed at ascertaining the abilities to analyze and re-elaborate the concepts acquired and a series of interactive activities (E-Tivity). Etivities are evaluated from 0 to 5 points, is carried out, during the course. The exam is evaluated for the remaining 0 to 25 points and can be done in written form both at the Rome office and at the educational poles upon booking by the student.
The written test can include both numerical exercises and different theory questions to be carried out in 90 minutes. The exercises present in the exam will concern the most applicative modules present in the platform.

Bibliography and resources

Material provided by the teacher

Recommended bibliography:

D. J. Ewins, Modal Testing: Theory, Practice and Application,John Wiley & Sons (2000)
Maia,Silva, Theoretical and Experimental Modal Analysis,ohn Wiley & Sons Inc (1997)