Course guide
205608 - 205608 - Flow Induced Vibration

Last modified: 19/04/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 729 - MF - Department of Fluid Mechanics.

Degree: MASTER'S DEGREE IN RESEARCH IN MECHANICAL ENGINEERING (Syllabus 2021). (Optional subject).

Academic year: 2023 **ECTS Credits:** 3.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: Eduard Egusquiza Estevez

Others: Eduard Egusquiza Estevez

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE3-MUREM. Analyze and formulate dynamic phenomena for their application in the development of each and every one of the phases of conception, design and calculation and simulation of advanced dynamic elements and fluids.

TEACHING METHODOLOGY

Description of basic phenomena
Projects in cases of interest in engineering using lab tests and numerical simulation

LEARNING OBJECTIVES OF THE SUBJECT

The subject (flow-induced vibrations) deals with the vibrations generated by a flow of fluid on (flexible) structures. These phenomena can occur in many fields of engineering such as mechanics, aeronautics and civil engineering.
A first goal is to present a unified approach to the subject that can be applied to different technological fields.
The first part provides knowledge to learn the different types of vibrations induced by flows with examples. We begin with a historical review with the aim of seeing how technological evolution has led to the emergence of these types of phenomena.
Basic concepts of fluid mechanics are reviewed for the understanding of vorticity, boundary layer, remnants and coefficients of support and resistance. Describe what types of excitatory forces a flow can produce on a structure,
A part of basic signal processing is incorporated to be able to analyze the vibrations and oscillations of the fluid. Here are the modes of vibration of structures in order to identify their natural frequencies and modes.
This basis studies in detail the vibrations on bodies generated by vorticity and their possible coupling to structural motion. Examples of blunt bodies and aerodynamic profiles are presented. A project is developed to analyze with a theoretical analysis and an experimental part the vibrations produced by the detachment of vortices.
The aim is to find out the vibrations produced by turbulence with an application on buildings and finally introduce complex cases of interaction between flow and structural motion such as flutter.

STUDY LOAD

Type	Hours	Percentage
Self study	48,0	64.00
Hours large group	27,0	36.00

Total learning time: 75 h

CONTENTS

Flow induced vibrations

Description:

1. Introduction
Historical background. Evolution from rigid to flexible structures
Flow induced vibrations
Classification
Interest and applications
Examples in several engineering fields: cables, chimneys, bridges, solar panels, ...
Examples of catastrophes caused by FIV: The Tacoma narrows bridge collapse

2. Flow excitations
2.1. Generation of vorticity.
Flow around bodies
Boundary layers, wakes
Lift and drag coefficients. Static and dynamic components
2.2. Vortex Induced Vibrations
Vortex shedding
Lock-in
Mitigation
Practical examples.
3. Body oscillators
Basic equations for dynamics: inertia, damping and stiffness
Structural dynamics, natural frequencies and mode-shapes
Added mass and damping effects
Practical examples
4. Vortices
Vorticity and vortices
Types of vortices
Basic laws
Vortices in different fields of engineering
Vortices in turbomachinery
Cavitation instabilities
Examples
5. Introduction to signal analysis
Analysis in the time-domain
Analysis in the frequency domain. The Fast Fourier Transform.
Joint Time-frequency domain
Practical examples
6. Forced vibrations in bluff bodies
Turbulence buffeting.
Spectral characteristics of wind.
Buffeting in high-rise buildings
Practical examples
7. Self-excited vibrations
Flutter, galloping
Flutter in compressor blades
Flutter in solar panels
Practical examples

Related competencies :
CE3-MUREM. Analyze and formulate dynamic phenomena for their application in the development of each and every one of the phases of conception, design and calculation and simulation of advanced dynamic elements and fluids.

Full-or-part-time: 75h
Theory classes: 27h
Self study : 48h

GRADING SYSTEM

Final exam 50%
Projects 50%
All those students who want to improve their result will have the option of recovering it through an additional written test that will be carried out on the same day set for the final exam). The qualification of this redirection test will be between 0 and 10, replacing that of the partial exam as long as it is higher.

BIBLIOGRAPHY

Basic:
- Blevins. Flow induced vibrations. Van Nostrand Reinhold International, ISBN ISBN-10 : 0442206518 ISBN-13 : 978-0442206512.