Vibration Analysis of Structures

Programme course

6 credits

Strukturdynamik

TMME40

Valid from: 2017 Spring semester

Determined by
Board of Studies for Mechanical Engineering and Design

Date determined
2017-01-25

Main field of study
Mechanical Engineering

Course level
Second cycle

Advancement level
A1X

Course offered for
- Mechanical Engineering, M Sc in Engineering
- Industrial Engineering and Management - International, M Sc in Engineering
- Industrial Engineering and Management, M Sc in Engineering
- Mechanical Engineering, Master's programme

Entry requirements
Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

Prerequisites
Mechanics, as well as basic courses in mathematics, mechanics of materials and structural engineering.

Intended learning outcomes

The purpose of the course is to provide the students with greater knowledge of vibration, necessary for many applications within industry which are associated with dynamic processes, for example. Many vessels are exposed to vibrations; also, transverse vibrations occur in airplane wings when the airplane descends for a landing. These vibrations can result in high stress on materials, which could result in material failure in the worst case situation. Therefore it is important for the future civil engineer to be able to analyze and dimension structures which are subjected to dynamic loads. A large number of methods for analysis of vibrating structures are given in the course. One important objective is to give the student insight into the applicability, use, and limitations of the methods. Further, that they can be used critically and in such a way that the numerical performance of the methods can be explained with well supported and formulated theory.After the course, the student should be able to:

- Modeling simple and more complex mechanical systems.
- Define the basic concepts in structural dynamics as velocity,acceleration,force,couple,energy,frequence,period,damping factor,excitation,system characteristics,response.
- Be able to perform simple derivations of theorems and expressions used in the cource.
- Use modal analysis,approximate and exact methods to solve the eigenvalueproblem,and to be able to solve for frequences and eigenmodes for different element of structures.
- Use the principle of Hamilton and Lagranges equations to obtain the govering equations for a structure,and solve these analytically or numerically by using MATLAB.
- Determine the type of stability for simple non-linear systems.

Course content

Brief review of Newton's laws. Systems with one and several degrees of freedom. Methods for determining natural frequencies. Modal analysis. Discrete and continuous systems (damped and undamped), orthogonal and normal coordinates. D'Alembert's principle, Lagrange's equations for linear systems. Approximative methods for continuous systems. Finite element method. Non linear systems, stability criteria, geometric methods, perturbation methods. Various computation techniques, transfer matrices, discrete time systems. Runge-Kutta methods.

Teaching and working methods

Instruction is carried out in the form of large seminars.

Examination

UPG2	Hand-in exercises	6 credits	U, 3, 4, 5

Grades
Four-grade scale, LiU, U, 3, 4, 5

Department
Institutionen för ekonomisk och industriell utveckling

Director of Studies or equivalent
Peter Schmidt

Examiner
Jonas Stålhand

Course website and other links

Education components
Preliminary scheduled hours: 48 h
Recommended self-study hours: 112 h

Course literature

Additional literature

Books
Meirovitch, L, *Elements of Vibration Analysis*