



# FSD3180 Non-linear Vibrations

## 7.5 credits

Ickelinjära vibrationer

This is a translation of the Swedish, legally binding, course syllabus.

If the course is discontinued, students may request to be examined during the following two academic years

### Establishment

Course syllabus for FSD3180 valid from Spring 2018

### Grading scale

### Education cycle

Third cycle

### Specific prerequisites

PhD students in the mechanics field.

### Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

### Intended learning outcomes

After the course, the participant shall be able to:

- Apply perturbation methods to new situations:
  - Predict the response of a novel, non-linear system – approximated by a conservative, finite degree-of-system – using a perturbation method.
  - Predict the response of a novel, non-linear system – approximated by a non-conservative, finite degree-of-system – using a perturbation method.
  - Calculate all the resonance frequencies of a forced, novel, non-linear system – approximated by a non-conservative, single degree-of-system – using a perturbation method.
  - Demonstrate a correct use of a perturbation method in the prediction of the standing wave response of a novel, non-linear continuous system – such as string, beam, plate or shell.
  - Predict the travelling wave response of a novel, non-linear continuous system using a perturbation method.
- Analyze non-linear acoustic phenomena:
  - Identify the non-linear phenomena for finite degree-of-freedom systems.
  - Point out the reasons for the non-linear phenomena for finite degree-of-freedom systems.
  - Identify the non-linear phenomena for continuous systems.
  - Point out the reasons for the non-linear phenomena for continuous systems.
- Judge the value of applied perturbation methods for a given application:
  - Write a short exposition evaluating the relative merits of the applied perturbation methods.
  - Compare the response results predicted by a perturbation method with those of a basic numerical method.
  - Explain the reasons for a good match between results obtained by a perturbation method and those of a basic numerical method.
  - Explain the reasons for any mismatch between results obtained by a perturbation method and those of a basic numerical method.
- Display a scientific attitude towards non-linear problems:
  - Demonstrate curiosity in identifying non-linear problems.
  - Seek natural causes of non-linear phenomena.
  - Demonstrate open-mindedness when seeking solutions.
  - Suspend judgments until all evidence is available.
  - Show objectivity in analyzing evidence and drawing conclusions.
  - Show willingness to revise conclusions as new evidence becomes available.

## Course contents

**Contents:** Conservative and non-conservative systems, forced oscillations of systems, continuous systems and traveling waves.

**Methods:** Perturbation methods – such as straightforward expansion, Lindstedt-Poincaré method, method of multiple scales, method of harmonic balance, method of averaging – and basic numerical methods.

## Disposition

This course is learning-centered, supporting a view of learners as active participants in their own learning while using continuous formative assessments with no need for a final examination. To this end, the learners are supposed to take active part in the lectures; encom-

passing active discussions but also involving active reflective observations while promoting creative solutions.

## Course literature

"Non-linear Acoustics" Leif Kari - lecture notes

Course literature consists of lecture notes

## Equipment

None

## Examination

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

No final examination.

### **Home assignments:**

The learning outcomes are continuously assessed by totally about 4-5 home assignments where methods learned and skills developed during the course are applied to new situations while requiring both analyzing and evaluation of the results and methods used. It is permissible to cooperate on the assignments, but they must be handed in individually and written in pencil (no computer print outs).

### **Scientific paper review:**

A recently published scientific paper using some of the methods learned is individually reviewed during the final part of the course. The method used and results shown are critically evaluated while also suggesting some alternative approaches. The results of this review are given at a seminar and in a short individual report – covering approximately one to two A4 papers.

## Other requirements for final grade

Approved home assignments handed-in in time, scientific paper review seminar and report.

## Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.

- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.