FSG3123 Perturbation Methods in Mechanics 7.5 credits

Störningsmetoder i mekanik

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

Establishment

Course syllabus for FSG3123 valid from Spring 2019

Grading scale

P, F

Education cycle

Third cycle

Specific prerequisites

Basic knowledge of ordinary differential equations, Mechanics and Matlab.

Language of instruction

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

Intended learning outcomes

Once the course will be completed, the student should be able to:

- Explain basic concepts of perturbation techniques, such as order relationships, asymptotic sequences, asymptotic expansions and convergence issues.
- Propose a solution method for regular perturbation problems
- Explain the difference between a regular and a singular perturbation problem
- Analyze a singular problem by means of a balancing method, methods of strained coordinates and boundary-layer theory
- Determine inner and outer solutions for singular perturbation problems by means of boundary-layer theory and the composite form
- Use WKB methods to solve linear ordinary differential equations subjected to different length or time scales
- Perform a multiple-scale analysis on linear and non-linear problems
- Apply perturbation methods to partial-differential problems

Course contents

The course is designed for graduate students in the engineering sciences to provide to them familiarity with perturbation methods, with special focus on how these methods provide useful insight in mathematical problems encountered in physics and engineering. The solution of ordinary differential equations with one small/large parameter will be analyzed, both within the framework of regular- or singular-perturbation theory, with special attention on boundary-layer theory, WKB approaches and multiple-scale analyses. The extension of the methods to partial-differential equations will also be discussed.

Disposition

The course consists of 14 two-hour lectures with 6 assignments. From the 3rd meeting, lectures will alternate with problem-solving classes, where students will discuss at the whiteboard their solution of pre-assigned problems from the Wilcox book, possibly showing comparisons with numerically integrated equations or analytical solutions. The discussion of at least one assigned problem is compulsory to pass the course.

The final exam shall consist of a home assignment to be delivered to the teachers.

Course literature

- D. Wilcox (1995) Perturbation methods in the computer age. DWC Industries Inc.
- E. J. Hinch (1991) Perturbation methods. Cambridge University Press.
- C. Bender & S. Orszag (2010) Advanced mathematical methods for scientists and engineers. Springer

Examination

- DEL1 - Participation, 1.5 credits, grading scale: P, F
- INL1 - Assignment, 6.0 credits, grading scale: P, F

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.

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

DEL1 Participating 1,5 hp (P, F)

INL1 Inlämningsuppgift 6,0 hp (P, F)

Other requirements for final grade

- Active participation to the lectures and, in particular, to the problem-solving classes.
- Homework assignment.

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.