

**SYLLABUS**

# **Finite Element Method 7.5 credits K7014B**

**Finita elementmetoden**

**Course syllabus admitted: Autumn 2023 Sp 1 - Present**

**DECISION DATE  
2021-02-17**

# Finite Element Method 7.5 credits K7014B

## Finita elementmetoden

### Second cycle, K7014B

<b>Education level</b>	<b>Grade scale</b>	<b>Subject</b>	<b>Subject group (SCB)</b>
Second cycle	G U 3 4 5	Konstruktionsteknik	Building Technology

## Entry requirements

Knowledge in mathematics corresponding to M0031M Linear Algebra and Differential Equations.  
Knowledge in strength of materials and solid mechanics and structural mechanics corresponding to B0002B Structural Engineering and B7004B Structural Mechanics I.  
Knowledge about load carrying capacity of structures corresponding to K0013B Structural Design, K7012B Structural Design or S0007B Fire Exposed Structural Elements.

## Selection

The selection is based on 30-285 credits

## Course Aim

At the end of this course, you will be able to:

1. Define and explain the main steps of the Finite Element Method (FEM).
2. Identify the different finite element types and when to use them.
3. Understand impact on the size, number and shape of the elements.
4. Understand how different boundary conditions are to be modeled.
5. Understand when, where and how symmetry can be used.
6. Develop a finite element model using the software ATENA.
7. Identify and explain when to use the different FEM analyses types.
8. Calculate the principal strains and stresses in a structural element

# Contents

The course is organized in modules, A to C and sub-parts according to:

## A. Introductions to Finite Element Method (FEM)

- What is FEM?
- Why and when use FEM?
- Basic concepts (DOF, node, element, stiffness)
- FEM analysis types and applications
- Main FEM steps for structural analysis
- Introduction to software ATENA

## B. FEM theory

- Stress and strain review
- Weak and strong formulations
- Linear analysis vs nonlinear analysis
- Principle of virtual work
- Types of elements
- FEM for truss and bars
- FEM for beams and frames
- FEM for plates/shells (2D)
- FEM for solids (3D)

## C. FEM in practice

- Pre-processing
- Processor
- Post-processing
- Model checking
- Typical FEM errors

Module A – presents an overview of the Finite Element Method (FEM) and basic definitions. The main purpose of this module is to highlight the FEM importance in structural analysis as well as its advantages and limitations. Also, in this module the software ATENA is introduced showing its main applications and recent developments in structural engineering.

Module B – introduces the background theory to FEM, where a review in strain and stresses will be presented and the difference between typical FEM analyses will be given. Here general formulations for different element types will be addressed.

Module C – constitutes the description of the main FEM steps for structural analysis. Each step will be explained and showed how can be implemented using a commercial software. In this module some application examples will be used.

## Realization

Each course occasion's language and form is stated and appear on the course page on Luleå University of Technology's website.

Course format (Teaching):

The course requires your involvement in various processes of learning. It consists of planned lectures, a quiz, tutorials and project assignments. The finite element software is installed in computer laboratories, the location of laboratories will be provided at the start of the course.

Lectures

The teacher will present the topic of the day of each lecture. The lectures will focus mostly on presentation of theoretical concepts.

Seminars

During these seminars, the teacher will present examples of applied theory and design methods, and the students will also work individually with examples. The teacher will assist them during this time and give feedback on the student's work. This will be the best opportunity to ask the teacher if you follow the right path and ask for advices when you encountered difficulties related to the Project assignments (see below). This process will address ILO's 3 and 4 (see above).

Project assignment

During this course you will solve one project assignment. You will choose the assignment yourself from previous courses in which you have designed a structural element, e.g. from concrete structures, steel structures, etc. Then you will simulate the behaviour of that element in linear and non-linear domain and compare the results from the previous design. A template will be provided for the project assignment. The assignment is individual. We will use a peer-review system to evaluate the reports.

Questions and answers sessions

At scheduled dates you will meet a teacher online or in computer laboratory to discuss solutions for modelling. Challenges you might encounter.

Quizzes will be used as a form of assessment of knowledge thought the course. The first quiz will open before we meet in Canvas or during our first lecture and serves as an evaluation form of your prior knowledge. The role of this quiz is to let us teachers understand what your level of knowledge at the course start is. The results will allow us to adjust the content of the course so that the intended learning outcomes will be reached.

The final quiz will be available after all theory lectures will be presented and approximately one to two weeks before the oral exam (depending on the Easter vacation). The quiz will consist of theory question with single, multiple answers and explanation with focus on outcomes 1-3. Quizzes will be available in Canvas.

## Examination

If there is a decision on special educational support, in accordance with the Guideline Student's rights and obligations at Luleå University of Technology, an adapted or alternative form of examination can be provided.

The outcomes of the course are assessed through oral examination. This will be carried out in form (1) discussion of the quiz results, where different questions will be discussed and analysed and (2) presentation of the project assignment.

(1) The quiz will consist of theory question with single, multiple answers and explanation with focus on outcomes 1-5, 8. To enter the oral examination, you will have to score at least half plus one points of the total number of points. You will be allowed two attempts to conduct the quiz. Where the second attempt should be at least one week apart from the first one.

(2) The oral examination will consist in evaluating your abilities to present, defend and justify the project results and the comparison with the design from the previous courses. The project should be presented in Powerpoint.

With the first form of examination, it is intended to assess outcomes 1-5, 8 while with the second outcomes 4-8. The oral examination will take about 60 minutes for each student out of which 20-25 min should be the presentation and the rest of the time will be allocated to discussions.

Projects assignment report must be submitted, corrected and approved prior to exam. It is a precondition to enter exam. All moments of the course are mandatory.

Grading scale G/U 3 4 5 will be used.

Code	Description	Grade scale	HP	Status	From period	Title
0001	Oral exam	G U 3 4 5	4.50	Mandatory	S21	
0002	Project assignments	U G#	3.00	Mandatory	S21	

## Unauthorized aids during exams and assessments

If a student, by using unauthorized aids, tries to mislead during an exam or when a study performance is to be assessed, disciplinary measures may be taken. The term "unauthorized aids" refers to aids that the teacher has not previously specified as permissible aids and that may assist in solving the examination task. This means that all aids not specified as permissible are prohibited. The Swedish version has interpretative precedence in the event of a conflict.

## Course offered by

Department of Civil, Environmental and Natural Resources Engineering

## Modules

Code	Description	Grade scale	Cr	Status	From period	Title
0004	Oral examination	G U 3 4 5	4.5	Mandatory	A21	
0005	Project assignments	U G#	3	Mandatory	A21	

## Last revised

by Assistant Director of Undergraduate Studies Eva Gunneriusson, Department of Civil, Environmental and Natural Resources Engineering 2021-02-17

## Syllabus established

by Assistant Director of Undergraduate Studies Eva Gunneriusson, Department of Civil, Environmental and Natural Resources Engineering

Resources Engineering 2019-02-14