Reg No: MSGC15/20231

Faculty of Health, Science and Technology
Mechanical Engineering

Syllabus

Finite Element Methods: Basics

Course Code:	MSGC15
Course Title:	Finite Element Methods: Basics *Finita elementmetodens grunder*
Credits:	7.5
Degree Level:	Undergraduate level
Progressive Specialisation:	First cycle, has at least 60 credits in first-cycle course/s as entry requirements (G2F)

Major Field of Study:
MTA (Mechanical Engineering)

Course Approval
The syllabus was approved by the Faculty of Health, Science and Technology 2022-08-31, and is valid from the Spring semester 2023 at Karlstad University.

Prerequisites
Registered for Linear Algebra, 7.5 ECTS credits, Calculus in Several Variables, 7.5 ECTS credits, Numerical Methods, 7.5 ECTS credits, and Solid Mechanics, 15 ECTS credits, or equivalent

Learning Outcomes
The aim of the course is for students to acquire basic knowledge of the theoretical foundation of the Finite Element Method (FEM) and skills to use commercially available software for FEM to solve engineering problems.

Upon completion of the course, students should be able to:
- explain basic concepts such as node, element, degree of freedom, and stiffness matrix,
- give an account of the meaning of the virtual work principle,
- give an account of how the virtual work principle can be used combined with appropriate

displacement approaches to derive element stiffness matrixes for different types of mechanical element structures such as bars, beams, and disc elements,
- explain the meaning of isoparametric element and Galerkin's method,
- analyse structures of one and two-dimensional bars and plane beams, both theoretically and with a commercial FEM-program,
- use disc, plate, and shell elements to analyse solid mechanics problems with the help of a commercial FEM-program,
- explain the meaning of material and geometric non-linearity problems respectively and analyse problems with elastic-plastic material description with the help of a commercial FEM-program,
- give an account of the Newton-Raphson method for solving non-linear problems with one variable,
- give an account of linear instability analysis with FEM,
- calculate neutral frequencies with the help of a commercial FEM-program,,
- explain the concept convergence and how convergence studies are performed with FEM,
- identify the cause of common types of problems in FEM-analysis.

Content
Instruction is in the form of lectures and exercises on:
- matrix statistics
- element stiffness matrixes for different types of elements, primarily bars, beams, and plane elements
- assembly of stiffness matrix structures
- linear elastic analysis of elastic supporting bar structures, beam and shell constructions and plane and axisymmetrical structures
. elastic-plastic analysis
- linear stability and neutral frequency analysis

Reading List
See separate document.

Examination
Assessment is based on hand-in assignments and a written exam.

If students have a decision from Karlstad University entitling them to Targeted Study Support due to a documented disability, the examiner has the right to give such students an adapted examination or to examine them in a different manner.

Grades
One of the grades Fail (U), 3 (Pass), 4 (Some Distinction), 5 (Distinction) is awarded in the examination of the course.

Quality Assurance
Follow-up relating to learning conditions and goal-fulfilment takes place both during and upon completion of the course in order to ensure continuous improvement. Course evaluation is partly based on student views and experiences obtained in accordance with current regulations and partly on other data and documentation. Students will be informed of the result of the evaluation and of any measures to be taken.

Course Certificate
A course certificate will be provided upon request.

Additional information
The local regulations for studies at the Bachelor and Master levels at Karlstad University

stipulate the obligations and rights of students and staff.