LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Balkteori
Beam Theory

VSMN35, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED V
Date of Decision: 2023-03-21

General Information

Elective for: V4-ko
Language of instruction: The course will be given in Swedish

Aim

The course shall give knowledge about the action of straight and curved beams and about theories for calculation of stiffness, deformations, stresses and instability of beams loaded in 3D, including influence of eigenstresses, and with cross-sections that may vary along the beam and have arbitrary geometrical shape, including thin walled cross-sections.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- Be able to give account of different kinds of beams, their mechanical action and performance, and phenomena that limit their servicabilty.
- Be able to give account of the beam theories of Bernoulli-Euler, Timoshenko, St Venant and Vlasov, and for the basics of analysis of instability of beams.
- Be able to explain the concepts, quantities and constants that are used in advanced beam calculations

Competences and skills
For a passing grade the student must

- Be able to calculate deformations, stresses and instability loads for a straight linear elastic beam with arbitrarily varying cross-section shape and loaded in 3D by forces, bending moments, torque, secondary moment and eigenstresses.

- Be able to calculate, exactly or numerically approximately, the stiffness matrix and load vector for beams of the above kind and how to use these for analysis of structures composed of beams.
- Be able to calculate deformations and stresses for a curved elastic beam loaded in 2D.
- Be able to calculate the cross-section constants for a beam cross-section of arbitrary shape.
- Be able to how a calculation has been carried out.
- Be able to use tables and handbooks with information about beam constants and instabilities.

Judgement and approach
For a passing grade the student must

- Be able to assess the way of action and properties of a beam (deformation pattern, stiffness properties, stress distribution and instability phenomena) based on the geometrical shape and loading of the beam.
- Be able to assess which type of calculation methods is most appropriate.

Contents

The course relates to methods of calculation elastic beams with symmetric/unsymetric, open/closed, solid/hollow constant/varying cross sections, exposed to loading in 3D, including distributed bending, torque, secondary moment and eigenstress:

- A summary of different types of beams, phenomena that limit structural serviceability and theories for beam analysis.
- The Bernoulli-Euler and Timoshenko theories for the response to bending moments, shear forces, normal force and eigenstress.
- The St Venant and Vlasov theories for analysis of torsion.
- Second order theory for instability phenomena like buckling in bending and torsion and transverse loading.
- Analytical and numerical solution of the differential equations of the different beam theories.
- Matrix formulation of beam stiffness and loading for computer based analysis of 3D framework structures.

The course comprises hand-in tasks which relate to experimental testing and theoretical calculation of stiffnesses, deformations, stresses and instability loads.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: The course examination comprises hand-in tasks and a written examination. Both parts have to be passed. The mark is based on the sum of the points of the two parts.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Admission

Admission requirements:

- VSMA05 Structural Mechanics or VSMA11 Structural Mechanics or VSMA20 Structural Mechanics

Assumed prior knowledge: VSMF05 Engineering Modelling: Analysis of Structures.
The number of participants is limited to: No
The course overlaps following course/s: VSM091, VSMF15

Reading list

- Compendium with lecture notes, exercises and formulas. Instructions for assignments.

Contact and other information

Course coordinator: Henrik Danielsson, henrik.danielsson@construction.lth.se
Course homepage: http://www.byggmek.lth.se
Further information: Lectures and exercises. It also includes experimental tests with documentation of experimental setups and results.