

Internationell svetskonstruktör, IWSD - Kursprogram

Design specialisation (M2 & M3)

Module 2: STRENGTH OF MATERIALS / Allmänt om Hållfasthet

2.1 Static equilibrium/Statiska system, 3 tim

Objective:

To be acquainted with basic concepts of static equilibrium from simple structures and how these are applied in the analysis of simple structural elements.

Scope:

Equilibrium of forces
Equilibrium of moments
Action and reaction forces
Free body diagram
Shear and moment diagrams
Tension, compression, shear, bending and torsion force components

Expected result at comprehensive and standard levels:

Review basic principals of statics and dynamics that are relevant to understanding the behaviour of structures.

Explain different forces components that can act on a structure and how these are defined.

Compute of a statically determinate beam or other simple solid.

Identify statically determinate and statically indeterminate structures.

Present shear moment diagrams for beam and frame type structures.

2.2 Stress, strain and deformation/Spänning, töjning och deformationer, 3 tim

Objective:

To understand the basic concepts of stress, strain, strength and deformation of solids.

Scope:

Normal stresses and strains
Shear stresses and strains
Elastic deformation of solids
Static and dynamic forces
Plastic deformation of solids
Stress strain curves for materials
Yield strength
Mohr's circle

Expected result at comprehensive and standard levels:

Present basic definitions of normal and shear stresses.

Illustrate the relationship between stresses and strains for common structural materials.

Illustrate importance of yield strength and ultimate strength for simple structural elements.

Compute stresses and strains of simple statically loaded structural elements.

Illustrate yielding for combined loading.

2.3 Failure criteria for structures and structural materials/Brottkriterier, 4 tim

Objective: The student will be introduced to potential common failure modes for structures and structural materials.

Scope:

Yielding, Multiaxial stresses, Plastic collapse, Ultimate strength, Fatigue and fracture, Global buckling, Local buckling, Lateral buckling, Slenderness

Expected result at comprehensive and standard levels:

Illustrate common modes of failure for structural elements.

Compute ultimate load-carrying capacity for typical structural members based of strength of materials.

Explain features of real structures that differ from the idea solutions and how these affect strength.

Explain the basic principles of elastic and plastic design.

Illustrate selection process for simple structural elements based on strength of materials analysis.

Compute strength of a simple element based on both elastic and plastic strength.

2.4 Introduction to fatigue/Introduktion till utmattning, 6 tim

Objective:

The student will understand the keys concepts related to fatigue of materials and structures.

Scope:

Definition of a fatigue load cycle
Variable amplitude loading
Cumulative damage
Crack growth
Mean stress
Stress range
Stress concentrations
S-N curve
Fatigue limit

Expected result at comprehensive and standard levels:

Illustrate basic features of cyclic loading including stress range, stress amplitude, mean stress.
Illustrate variable amplitude loading and cumulative damage.
Explain importance of mean stresses, stress concentration and surface finish on fatigue life.
Illustrate concepts of fatigue strength, fatigue life and fatigue limit.
Compute design life for a simple structural element using S-N –curve.
Illustrate how relevant information can be obtained from design guidance documents, e.g., IIW Doc. XIII-1965-03/XV-1127-03 "Recommendations for fatigue design of welded joints and components".

2.5 Introduction to fracture mechanics/Introduktion till brottmekanik, 5 tim

Objective:

The student will be introduced to fracture modes and how the stress intensity factor can be used in modelling fatigue crack growth and brittle fracture.

Scope:

Stress intensity factor
Brittle fracture
Ductile fracture
Fatigue crack growth
Paris equation
Plastic zone
Critical stress intensity factor

Expected result at comprehensive and standard levels:

Explain mechanism and common features of ductile fracture of structures.
Explain mechanism and common features of brittle fracture of materials and structures.
Explain fatigue crack growth based on linear elastic fracture mechanics.
Illustrate relationship between fracture type and surface appearance.
Review an industrial failure case involving fracture.
Explain the stress intensity factor, stress intensity factor range and critical stress intensity factor.
Compute stress intensity factors for a simple geometry using geometry factors.
Review experimental method related to fracture.

2.6 Material properties/Materialegenskaper, 4 tim

Objective:

The student will understand several of the critical material parameters used to assess to suitability of a structure or structural material.

Scope:

Yield and ultimate strength
Elongation
Fracture toughness
Elastic modulus
Poisson ratio
Fatigue limit

Expected result at comprehensive and standard levels:

Explain the stress strain behaviour on common structural materials.
Demonstrate how material properties are derived from a tension test.
Compute the elastic and plastic limit load of a simple structural member.
Illustrate the importance and limitation of the fatigue limit in design.
Explain the importance of elongation /ductility for ultimate load design.

Module 3: DESIGN OF WELDED STRUCTURES / Utformning av svetsade konstruktioner

3.1 Basic theory of structural systems/Grundläggande konstruktionsteori, 4 tim

Objective:

The student should understand the basic classes of structural elements and how these elements are combined in a simple structure.

Scope:

Tension elements
Compression elements
Beam elements
Truss and frame structures
Plate elements
Joining and connections

As appropriate a suitable design guidance document, e.g., EN 1993 Eurocode 3: Design of Steel Structures, may be used

Expected result at comprehensive and standard levels:

Explain the basic features of different structural elements and how these are used in design.
Explain the structural differences between moment bearing and non-moment bearing connections.

Explain the potential failure modes associated with the different structural elements.

Compute ultimate strength of tension members.

Compute shape factor, plastic limit load and elastic limit load for beam element.

Understand the basic difference in load transfer mechanism for a beam element constructed of plates and one constructed of tension/compression truss elements.

3.2 Loads on structures/Laster på konstruktioner, 4 tim

Objective: The student will understand the important distinction between different classes of loads acting on a structure and be aware of how to compute loads for design.

Scope:

Dead loads
Live loads
Distributed and concentrated loads
Partial safety factors for loads
Design loads
Statistical load variation

As appropriate a suitable design guidance document, e.g., EN 1991 Eurocode 1: Actions on structures, may be used

Expected result at comprehensive and standard levels:

Explain possible sources for dead loads and live loads that can act on a structure.

Understand how static and moving loads affect a structure.

Compute the design load for a structure based on partial safety factors and load class.

Explain some of the sources for variation of loads.

Explain the concept of partial safety factor and how these are used in the design of structures.

Interpret appropriate standards with respect to computation of design loads.

Interpret appropriate standards with respect to load classification and partial safety factors for loads.

3.3 Introduction to the design of structures/Introduktion till konstruktionsutformning, 8 tim

Objective:

The objective is to provide an introduction to the philosophy and process of design for welded structures.

Scope:

Design goals and constraints
Safety, economy, durability and serviceability
Proportioning of members
Analysis and evaluation
Partial safety factors
Sources of variation in design loads and strength of structural components
Ultimate and serviceability limit states

Expected result at comprehensive and standard levels:

Clarify the set of design objectives that are placed on a structure.

Illustrate the design process first concept to detail design and final evaluation.
Introduce the concepts of optimisation with respect to performance, manufacturability, life cycle cost, etc.
Demonstrate the set of limit states that are placed on a structural system.
Illustrate the possible influences of manufacturing tolerances on the final design of a structure.
Explain the basic aspects of limit state design.
Illustrate the use of partial safety factors in calculations.
Compute loading combinations required in limit state design method.
Explain sources of load variation for welded structures.

3.4 Analysis methods for structures/Analysmetoder, 5 tim

Objective:

The student will be introduced to the use of simple and more sophisticated analytical tools in the design of structures.

Scope:

Spreadsheet tools
Finite Element Analysis
Design guideline formulas

Expected result at comprehensive and standard levels:

Demonstrate use of a spreadsheet based calculation system in the design of a structural system.
Explain the basis for selecting an appropriate analysis method for a design situation.
Explain the advantages, disadvantages and uses of different analysis methods.
Explain the use and interpretation of finite element results for steel structures design.
Correctly interpret and understand the use of design guideline formulas for calculation of design strength and design load.

3.5 Design guidance documents, codes and standards/Konstruktions-standards och riktlinjer, 4 tim

Objective:

The student will become familiar with the appropriate use of design guidance documents in the design of fabricated structures.

Scope:

Dimensioning
Partial safety factors
Design load
Design strength
Limit state design / allowable stress design

As appropriate, a suitable design guidance document, e.g., EN 1993 Eurocode 3-part 6: Design of Steel Structures: Crane supporting structures, EN 1993 Eurocode 3-part 2: Design of Steel Structures: Steel bridges, EN 13445: Unfired pressure vessels, etc., may be used.

Expected result at comprehensive and standard levels:

Understand the procedures recommended in one design guidance document for fabricated structures.
Compute design strength of a simple structural component using procedures outlined in one design guidance document.
Compute the needed design load for a structure considering both static and changing loads.
Identify from the design guidance document other related codes and standards related to materials, manufacturing, and calculation methods, etc.
Explain the basic features of the design guidance document being used.
Explain possible sources of exceptional / accidental loads on the structure being considered.
Understand the relationship between design strength and design load for a structure and failure probability.