

## 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.