COURSE DESCRIPTION CARD - SYLLABUS

Course name
Steel Structures II with BIM elements

Course

Field of study
Sustainable Building Engineering

Year/Semester
3/6

Area of study (specialization)

Profile of study
general academic

Level of study
First-cycle studies

Course offered in
english

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
30	0	0
Tutorials	**Projects/seminars**	
15	15	

Number of credit points

4

Lecturers

Responsible for the course/lecturer:
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Responsible for the course/lecturer:

Prerequisites

KNOWLEDGE: student knows the basic concepts in the field of structural mechanics and material strength in the field of content of the field of study Civil Engineering, basic issues of steel production technology used in construction and their strength and mechanical properties, Student has knowledge of types of welded and bolted joints and calculation procedures, knowledge of computer aided design methods (CAD).

SKILLS: student presents basic designs in the field of structural mechanics and material strength, the ability to select appropriate structural and technological solutions in the field of corrosion and fire protection as well as joints and elements of metal structures, the ability to prepare simple project documentation.

SOCIAL COMPETENCES: the student is aware of the need to broaden his professional competences and responsibilities related to project work. Has the ability to cooperate in a group and perform various roles in it.

Course objective

Objective of the course: to familiarize students with the specifics of structural systems and static steel halls. To introduce students to the principles of purlin work, types of cross-sections, static diagrams and loads. To introduce students to the principles of forming trusses from angles, double-wall trusses, from tees and angles, from pipes and I-beams, as well as the principles of forming nodes in trusses. Teaching students the basic methods of steel truss design. To familiarize students with the methods of dimensioning transverse roof bracings, longitudinal roof bracings, vertical longitudinal roof bracings (inter-girder), vertical columns and horizontal walls bracings.

Course-related learning outcomes

Knowledge

The student knows the national (PN) and European (EN) standards and technical conditions for the implementation of building structures in the field of designing structural systems and static steel halls and purlins. Knows the principles of forming trusses from angles, double-wall trusses, from tees and angles, from pipes and I-beams, as well as the principles of forming nodes in trusses and concentrations of steel halls. He knows the CAD environment and BIM-compatible programs enabling static calculations and dimensioning of steel structures in halls.

Skills

Student is able to obtain information from literature, databases and other properly selected sources; is able to integrate the information obtained, interpret it, as well as draw conclusions and formulate and substantiate opinions. Able to design the structural system of the roof of steel halls with trusses made of angle bars, double-walled trusses, tees and angle bars, pipes and I-beams, as well as design nodes in trusses and steel hall concentrations. Can carry out static analysis and dimensioning in BIM-compatible programs and prepare technical documentation in the CAD environment.

Social competences

Student is responsible for the reliability of the results of his work and their interpretation. Independently complements and expands the knowledge in the field of modern construction design techniques. Has the ability to critically assess the results of their own work.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: Final exam. Final exam on the content of lectures including closed questions and open tasks.

Auditorium exercises: colloquium. Colloquium on the content of the auditorium exercises in the form of tasks to be solved.

Credit is obtained from obtaining a minimum of 50% of the maximum number of points.

Laboratory evaluation

Credit obtained on the basis of the report generated in the program for the static analysis compatible to BIM and oral defense of the project.

Programme content

Lecture 1

Topic: Steel roof construction

Content: Basic concepts and definitions regarding the design of a steel roof structure. Functions of individual elements and their cooperation. Examples of steel roof construction.

Lecture 2

Topic: Loads and impacts on a steel roof

Content: General information on loads and impacts on construction works according to PN-EN 1991. Load types, partial safety factors and simultaneous load factors. Methods for determining actions on the roof structure, schemes and load combinations.

Lecture 3

Topic: Designing roof purlins

Content: Static diagrams, purlin loads, purlin support and assembly contacts. Verification of SGN and SGU of steel elements skew bented and compressed according to PN-EN 1993 part 1-1. Example of roof purlin modeling in the program for static analysis and dimensioning (BIM).

Lecture 4

Topic: Basics of steel truss design

Contents: General information, principles and assumptions regarding the forming of trusses in construction. Truss technology. Pros and cons of lattice constructions. Theoretical assumptions of truss design and deviations from classical methods of their calculation. An example of truss modeling in a program for static analysis and dimensioning (BIM).

Lecture 5

Topic: Designing roof trusses -1

Content: Basics of constructing and shaping roof trusses. Collection of loads for roof trusses, geometrical diagrams of trusses, static determinability and geometric invariance. Numerical modeling of trusses - adopting static (simplified and accurate) diagrams.

Lecture 6

Topic: Designing roof trusses -2

Content: General information, principles and assumptions regarding the formation of trusses from angles, tees, single-wall and double-wall. Rules for dimensioning this type of structure. Advantages and disadvantages.

Lecture 7

Topic: Designing roof trusses -3

Content: Basics of constructing and shaping trusses from round, square and rectangular hollow sections. Rules for dimensioning this type of structure. Advantages and disadvantages.

Lecture 8

Topic: Connections in trusses made of open sections

Contents: Basics of constructing and shaping nodes in trusses from angles, tees, single-wall and double-walled (welded and overlapped and bolted connections). Connection failure mechanisms and their calculation of the load capacity and susceptibility of the connections according to PN-EN 1993 part 1-8. Eccentricity of connections.

Lecture 9

Topic: Connections in hollow section trusses

Content: Basics of constructing and shaping connections in trusses made of hollow section (welded and overlapped and bolted joints). Connections load capacity and susceptibility. Connection failure mechanisms and their calculation of the load capacity and susceptibility of the connections according to PN-EN 1993 part 1-8. Eccentricity of connections.

Lecture 10

Topic: General stability of the steel roof structure

Content: Assumptions and theoretical foundations of the spatial work of the roof structure - general stability and geometric invariance. Types of roof bracing, loads, dimensioning and construction.

Lecture 11

Subject: Basics of steel hall design - 1

Content: Basic concepts and definitions related to steel structure design. Hall functions, structure and its components. Hall cladding - roofing and wall cladding. Examples of hall constructions.

Lecture 12

Topic: Basics of steel hall design - 2

Content: Methods for calculating halls. Rules for adopting computational models, static schemes - pros and cons. Selection of profiles for the construction of hall elements. Presentation of possible project

implementation tools. An example of 2D hall modeling in a program for static analysis and dimensioning (BIM).

Lecture 13

Topic: Connections in the construction of steel frames

Content: Basics of constructing and shaping connections between hall elements. Flexible, rigid, semirigid joints - classification and structure. Calculation of load capacity and compliance of the joints according to PN-EN 1993 part 1-8. An example of modeling joints in a program for static analysis and dimensioning (BIM).

Lecture 14

Topic: Technological issues

Content: Production, prefabrication and assembly of steel hall structures. Division into components, types of assembly connections. Assembly rules for steel hall structures.

Lecture 15

Subject: Summary of lecture content.

Content: Repetition and summary of material from lectures 1 to 14.

Auditorium exercises 1

Topic: Introduction to the design of the steel roof structure

Content: Principles and assumptions about shaping the roof. Adoption of roof construction elements and truss geometry. An example of collecting loads together with the choice of roofing.

Auditorium exercises 2

Subject: Example of roof purlin design - 1

Content: Adoption of a static scheme, collection of loads on the purlin and determination of the maximum cross-sectional forces. Checking the purlins SGN and SGU (bi-directionally bent and compressed element) according to PN-EN 1993 part 1-1 using a static analysis and dimensioning (BIM) program.

Auditorium exercises 3

Subject: Example of roof purlin design (full-walled element) - 2

Content: Calculation example of purlin suspensions and purlin connections to a girder.

Auditorium exercises 4

Subject: Example of a truss truss design - 1

Content: Collecting loads on the truss nodes, determining the maximum cross-sectional forces, designing truss components: upper flange, lower flange, grating - SGN. Checking the second limit state of the girder - SGU.

Auditorium exercises 5

Topic: Example of a truss truss design - 2

Content: Calculation example of truss construction details: intermediate nodes, support nodes, assembly contacts.

Auditorium exercises 6

Topic: Examples of design of transverse roof slope - 1

Content: Calculation example of transverse roof slope concentration: collecting loads, adopting a static concentration scheme and determining maximum cross-sectional forces, dimensioning of concentration bars.

Auditorium exercises 7

Topic: Examples of design of transverse roof slope - 2

Content: Calculation example for checking the stiffness condition for a concentration. Design and dimensioning of bracing connections with the supporting structure.

Auditorium exercises 8

Topic: Colloquium covering the content of the auditorium exercises.

Content: Colloquium covering auditorium exercises.

Laboratories 1

Subject: Introduction

Content: Theme release. Discussion of the basic functions of the program for static analysis.

Laboratories 2

Topic: Model definition in static analysis program

Content: Example illustrating the definition of the truss geometry and steel roof elements. Assigning cross-sections and material parameters to elements of a steel roof.

Laboratories 3

Topic: Loads

Content: Definition of loads and their combinations in the program for static analysis.

Laboratories 4

Topic: Static analysis

Content: Interpretation of static analysis results.

Laboratories 5

Topic: Dimensioning

Content: Setting buckling lengths and dimensioning parameters. Manual verification of selected results.

Laboratories 6

Topic: Constructing nodes

Content: Overview of the principles of constructing selected nodes.

Laboratories 7

Topic: Drawing documentation

Content: Overview of the principles of creating drawing documentation.

Laboratories 8

Subject: Summary

Content: Receipt and defense of reports.

Teaching methods

Lecture:

1) A method that provides informative, problem and conversational lecture

2) Case method

Auditorium exercises

1) Practice method

2) Case method

Laboratories:

1) Practice and design method

2) Search method

Bibliography

Basic

[1] Unified Design of Steel Structures, 1st Edition, Louis F. Geschwindner, John Wiley & Sons , 2008.

[2] The Behaviour and Design of Steel Structures to EC3.S, Trahair, M.A. Bradford, D.A. Nethercot, L. Gardner, Balkema, 2007.

[3] EN 1990 - Basis of structural design.

[4] EN 1993-1-1 - Design of steel structures - Part 1-1.

[5] EN 1993-1-8 - Design of steel structures - Part 1-8.

[6] Bródka J., Kozłowski A. (2013), Projektowanie i obliczanie połączeń i węzłów konstrukcji stalowych, Polskie Wydawnictwo Techniczne, 739s.

Additional

[1] Design of a Steel Structures 2nd Edition, L. da Silva, R. Simones and H. Gervasio, Willey Ernst&Sohn 2016 Structural Design of Steelwork to EN 1993 and EN 1994, , Lawrence Martin, Elsevier, 2007.

[2] Structural Stability of Steel: Concepts and Applications for Structural Engineers, Theodore V. Galambos, Andrea E. Surovek, John Wiley & Sons , 2008.

[3] Rzeszut K., Garstecki A., Interaction of clearances and imperfections – Stability problems of bolted steel structures w: EUROSTEEL 2014, 7th European Conference on Steel and Composite Structures. September 10-12, 2014, Naples, Italy, 183-184.

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,0
Classes requiring direct contact with the teacher	60	2,0
Student's own work (literature studies, preparation for tutorials, preparation for tests, project preparation) [1]	40	2,0

[1] delete or add other activities as appropriate