COURSE DESCRIPTION CARD - SYLLABUS

Course name
Steel Structures I

Course

Field of study
Sustainable Building Engineering

Year/Semester
3/5

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:
dr hab. inż. Katarzyna Rzeszut

email: katarzyna.rzeszut@put.poznan.pl

tel. 061 665 2097

Faculty of Civil and Transport Engineering

Piotrowo 5 60-965 Poznań

Responsible for the course/lecturer:

Prerequisites

KNOWLEDGE: student has basic general knowledge in the field of physics, mathematics, strength of materials and building mechanics as well as computer methods.

SKILLS: student is able to obtain information from indicated sources, e.g. standards. Has the ability to prepare simple project documentation and transform algebraic and arithmetic expressions.

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 specificity of materials used in metal constructions. To introduce students to the technology of the production of structural steel grades, the range of materials and products used in steel construction, as well as to the issues of corrosion and fire protection. Teaching students to design metal structures in the field of welded and bolted joints in axial and complex state of stress. Teaching students the basic methods of designing elements of metal structures subjected to tension, compression, shear or bending.

Course-related learning outcomes

Knowledge

Student knows the national (PN) and European (EN) standards and technical conditions for the construction works. Knows the principles of construction and dimensioning of elements and connections of metal building structures. Knows selected computer programs (also using BIM technology) supporting the calculation and design of structures.

Skills

Is able to obtain information from literature, databases and other properly selected sources; is able to integrate the obtained information, interpret it, as well as draw conclusions and formulate and substantiate opinions. Can make a collection of loads acting on building objects and perform a static analysis of statically determinate structural elements. Student can design selected elements and simple metal structures.

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: A method that provides informative, problem and conversational lecture.

Exercises: Exercise method - final test on the content of classes including closed form questions and open tasks. Colloquium on the content of the exercises in the form of tasks to be solved.

Assessment of individual projects in the form of: substantive evaluation of the project documentation made, regularity of work (entries in the consultation card and attendance during classes), project defense (written or oral).

Programme content

Lecture 1

Topic: Introduction to the design of metal structures

Content: Basic concepts and definitions regarding the design of metal structures according to Eurocodes and Polish standards. Structure reliability, construction classes, limit states, calculation models, impact of imperfections. Examples of metal structures.

Lecture 2

Topic: Steel production technology

Content: Steel grades used in construction and their mechanical properties at natural and elevated temperatures. Profile steel production technology and assortment of hot rolled, cold - rolled and welded products.

Lecture 3

Topic: Loads and impacts in construction works

Content: General information on loads and impacts on construction works according to PN-EN 1991. Types of loads. Methods for determining actions on structures, partial safety factors and load simultaneity coefficients. Schemes and load combinations according to Eurocodes and Polish standards.

Lecture 4

Topic: Introduction to the design of welded joints

Content: General information, principles and assumptions regarding the formation of welded joints. Weld technology. Advantages and disadvantages of welded joints.

Lecture 5

Topic: Principles of designing lap and butt welded joints

Content: Basics of constructing and shaping joints for fillet and butt welds. Mechanisms of overlapping and butt welded joints during stretching, shearing and bending. Dimensioning (SGN) of welded joints for fillet and butt welds according to PN-EN 1993 part 1-8. Marking of welds in workshop drawings.

Lecture 6

Topic: Introduction to bolted connection design

Content: General information, principles and assumptions regarding the formation of bolted connections. Technology of screw connections. Damage mechanisms and classification of bolted connections. Advantages and disadvantages of screw connections.

Lecture 7

Topic: Design principles of lap and butt bolted connections

Content: Basics of constructing and shaping lap and butt bolt connections. Mechanisms of their destruction during stretching, shearing and bending. Dimensioning (SGN, SGU) of lap bolt joints according to PN-EN 1993 part 1-8. Markings in workshop drawings.

Lecture 8

Topic: Steel tensioned elements

Content: Basic information on design methods and dimensioning of expanded metal construction elements. General rules. Design principles and recommendations. Accepted calculation models, static diagrams and cross-sections of tensioned bars. Tensile load conditions according to Eurocodes (PN-EN 1993 part 1-1) and Polish standards (limit states, calculation models, net cross-section). Examples of tensioned elements of metal structures.

Lecture 9

Topic: Global stability

Content: Assumptions and theoretical foundations. The concept of critical load capacity and critical moment. The impact of initial geometric imperfections on critical load bearing capacity and post-critical equilibrium paths. Buckling of compressed elements and dislocation of bent elements. Relative slenderness with buckling and buckling, buckling and buckling coefficient, strength and critical moment. Methods of protecting steel structures against general loss of stability.

Lecture 10

Topic: Compressed elements

Content: Basic information on the methods of design and dimensioning of metal structures. General rules. Design principles and recommendations. Acceptable calculation models, static diagrams and cross-sections of compressed bars. Compressive load conditions according to Eurocodes (PN-EN 1993 part 1-1) and Polish standards (limit states, calculation models, impact of imperfections, loss of stability). Examples of squeezed metal construction elements.

Lecture 11

Topic: bent elements

Contents: Basic information on the methods of design and dimensioning of bent elements of metal structures. General rules. Design principles and recommendations. Acceptable calculation models, static diagrams (continuous beams, slow-supported beams) and cross-sections of bent bars. Bending section class. Bending and shear load conditions according to Eurocodes (PN-EN 1993 part 1-1) and Polish standards (limit states, calculation models, loss of stability). Examples of bent elements of metal structures.

Lecture 12

Topic: Corrosion of metal structures

Content: Discussion of types of metal corrosion with particular emphasis on the electrochemical corrosion process. Types of corrosion protection: materials, technology of manufacture. Rules for shaping metal structures that increase their corrosion resistance. Corrosion of steels with increased corrosion resistance, stainless and acid-resistant.

Lecture 13

Topic: Fire protection of metal structures

Content: Fire models and chain of events in a fire situation. Thermal actions, calculation methods (critical temperature, fire curves, advanced calculation models), material parameters. Basics of steel structure design in fire conditions according to Eurocode (PN_EN 1993 part 1-2). Active and passive fire protection measures

Lecture 14

Subject: Summary of lecture content.

Content: Repetition and summary of material from lectures 1 to 13.

Lecture 15

Topic: Colloquium covering lecture content.

Content: Colloquium including lecture content.

Auditorium exercises 1

Topic: Introduction to the design of connections in metal structures

Content: General information, principles and assumptions regarding the shaping of connections in metal structures. Advantages and disadvantages of connections. Mechanisms of destruction of welded joints during stretching, shearing and bending. Dimensioning of welded joints according to PN-EN 1993 part 1-8. Marking of welds in workshop drawings

Auditorium exercises 2

Topic: Examples of overlapping welded joints design

Content: Examples of overlapped, stretched, bent and shear welded joints according to PN-EN 1993 part 1-8.

Auditorium exercises 3

Topic: Examples of designing T-joints for fillet welds

Content: Examples of T-welded joints for stretched, bent and shear fillet welds according to PN-EN 1993 part 1-8.

Auditorium exercises 4

Topic: Examples of designing butt welded joints

Content: Examples of welded joints for extended, bending and shear butt joints according to PN-EN 1993 part 1-8.

Auditorium exercises 5

Topic: Examples of design of lap joints

Content: General information, principles and assumptions regarding the formation of bolted connections. Damage mechanisms and classification of bolted connections. Examples of tensioned lap contact and eccentric tension according to PN-EN 1993 part 1-8.

Auditorium exercises 6

Topic: Examples of design of lap joints

Content: Examples of folded and shear bolt contacts according to PN-EN 1993 part 1-8.

Auditorium exercises 7

Topic: Examples of butt screw connection design

Content: Examples of tension butt screw contact according to PN-EN 1993 part 1-8.

Auditorium exercises 8

Topic: Colloquium covering the content of the auditorium exercises.

Content: Colloquium covering the content of the auditorium exercises.

Project 1

Subject: Introduction - connection design in metal structures

Content: Issuing project topics, discussing the principles of implementation and credit for projects.

Project 2

Subject: Design of welded and bolted connections - universal contact

Content: Determining the cross-section class and determining the bending and shear resistance of the cross-section. Determination of loads per contact. Determining the dimensions of overlays and examples. Example. Consultations.

Project 3

Subject: Design of welded and bolted connections - universal contact cont.

Content: Determining the number and dimensions of fasteners. Checking the load capacity of joints and checking the stress in sections weakened by holes according to PN-EN 1993 part 1-8. Example. Consultations.

Project 4

Topic: Design of welded and bolted joints - extended contact for a T-profile

Content: Determining the cross-sectional class and determination of the cross-sectional load capacity. Determination of loads per contact. Determining the dimensions of overlays and examples. Example. Consultations.

Project 5

Subject: Design of welded and bolted joints - extended contact for T-profile cont.

Content: Determining the number and dimensions of fasteners. Checking the load capacity of joints and checking the stress in sections weakened by holes according to PN-EN 1993 part 1-8. Example. Consultations.

Project 6

Subject: Design of butt screw connections

Content: Design of tension butt screw contact according to PN-EN 1993 part 1-8. Example. Consultations.

Project 7

Topic: Workshop drawings of contacts in metal structures

Content: Overview of the principles of making workshop drawings of welded and bolted joints: universal contact and extended contact.

Project 8

Topic: Submission of projects

Content: Final check of the correctness of the project, oral defense of the project.

Teaching methods

Lecture:

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

2) A method that looks for a case method

Auditorium exercises

1) Practice method

2) A method that looks for a case method

Design:

1) Practice method

2) Project 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