Field of study (Kierunek):

Civil Engineering (Budownictwo)

Subject Description Card (Karta Opisu Przedmiotu)

ISCED 2013-F Field of study: Building and civil engineering (code: 0732)

Name of the subject				Subject code		Semester
Structural Mechanics I *Mechanika budowli I*						**Autumn**
Subject		**Profile**		**Level of education**		
Facultative		**General academic**		**Full-time**		
Type of classes						**ECTS**
Lecture	**Practice**	**Laboratory**	**Project**	**Seminar**	**Exam**	
15	**15**	**-**	**30**	**-**	**YES**	**6**
Faculty conducting subject:	***Faculty of Civil Engineering*** ***Tel: +48 (34) 325 02 06***					
Teachers conducting subject:	***PhD. Eng. Krzysztof Kuliński*** mail: krzysztof.kulinski@pcz.pl ***PhD. Eng. Anna Jaskot*** mail: anna.jaskot@pcz.pl					

I. Card subject	
PURPOSE OF THE SUBJECT	
C01	Students gain knowledge about basic principles and concepts in Structural Mechanics.
C02	Mastering by students the ability to prepare influence lines for statically determinate structures and determine on the basis of these lines an extreme values of static quantities.
C03	Give the students the ability to classify and solve statically determinate systems.
PRELIMINARY REQUIREMENTS FOR KNOWLEDGE, SKILLS AND OTHER COMPETENCES	
1	Knowledge in Civil Engineering Mechanics and Strength of Materials.
2	Knowledge in Mathematical Analysis.
3	Knowledge of basic concepts in the field of beam/frame/truss structures.
LEARNING OUTCOMES:	
Knowledge: the graduate knows and understands	
EK1	the concepts in the field of structural mechanics and understands how to formulate and solve practical civil engineering problems.

Skills: the graduate can	
EK2	draw influence lines using the kinematic and static method for statically determinate structures. Can calculate extreme values of static quantities on the basis of influence lines. Student is able to calculate displacements for statically determinate systems. Moreover, student can interpret the obtained results and use them for further research.
Social competence: the student is ready to	
EK3	work individually and in a team.

PROGRAM CONTENT		
Type of classes - Lecture		**Number of hours**
L1	Introduction to basic concepts of Structural Mechanics I. Division and characteristics of engineering structures, physical and mathematical model of structures – calculation scheme.	1
L2	Kinematic structure analysis. Simple examples.	1
L3	Moving loads. Principles of drawing up the influence lines of static quantities – the static method.	1
L4	Kinematic method of drawing influence lines. The principle of reciprocity of reactions and displacements (Rayleigh) and the principle of reciprocity of displacements (Maxwell).	1
L5 L6	Continuous beams. Principles of drawing influence lines for continuous articulated beams. Influence matrices and envelopes for continuous beams.	2
L7	Using the lines of influence. Influence lines for nodal loads.	1
L8	Fundamentals of the theory of truss systems. Simple examples.	1
L9 L10	Influence lines for truss systems – the static and kinematic method.	2
L11	Truss systems - the principle of virtual work.	1
L12 L13	Beams with a curved or sloped axis, truss beams. Three-hinged arches, three-hinged frames and three-hinged truss arches	2
L14	System deflection influence lines.	1
L15	Final Exam.	1
	TOTAL:	**15**

PROGRAM CONTENT		
Type of classes - Practice		**Number of hours**
PT1	Introduction to the course. Discussion on the conditions to pass the	1

	subject. Kinematic analysis of planar systems.	
PT2 PT3 PT4	Preparation of influence lines for static quantities (reactions, cross-sectional forces) using the static method for simple and multi-span articulated beams.	3
PT5 PT6 PT7	Preparation of influence lines for static quantities (reactions, cross-sectional forces) using the kinematic method for simple and multi-span articulated beams.	3
PT8 PT9	Using lines of influence. Loading the influence lines, determining the most unfavorable position of the load on the structure, calculating static quantities from the external load on the basis of the influence lines.	2
PT10 PT11 PT2	Planar truss systems - general characteristics, basic assumptions, types and creation. Kinematic analysis of truss systems. Determination of normal forces in truss members. Preparation of influence lines using the static and kinematic method.	3
PT13	Application of the virtual work equation to calculate the displacements in planar trusses caused by mechanical and non-mechanical loads.	1
PT14	Analytical solution of three-hinged arches.	1
PT15	Final test.	1
	TOTAL:	**15**

PROGRAM CONTENT		
Type of classes - Project		**Number of hours**
P1	Introduction to the course. Overview of the credit conditions. Providing list of literature. Assumptions to assignment no. 1 – planar multi-span beam. Kinematic analysis	2
P2 P3	Shear and bending moment diagrams. Preparation of reaction forces and cross-sections influence lines using static and kinematic method. Exemplary complex beam calculations – part II.	4
P4 P5	Checking using the influence lines the internal forces in cross-sections. Calculation of extreme values of shear and bending moment in a given cross-section under the moving load.	4
P6 P7	Calculation of vertical displacement and rotation angle at a given points under the mechanical load.	4
P8	Submission of project no. 1 and defense discussion. Assumptions to assignment no. 2 – planar truss.	2
P9 P10	Kinematic analysis of truss system. The Cremona diagram method and the joint method. The Ritter's method (method of sections).	4
P11 P12	Preparation of influence lines for reactions and forces of cross-section using static method. Checking using the influence lines the reactions and internal forces in cross-section.	4

P13 **P14**	Calculation of extreme force values in a given cross-section from a moving unit. Loads with a specific pattern on the lower (upper) truss flange. Calculation of a given point horizontal or vertical displacement from the mechanical load. Changes in the distance between nodes.	4
P15	Submission of project no. 2 and defense discussion.	2
	TOTAL:	**30**

BASIC AND ADDITIONAL LITERATURE	
Basic literature:	
1.	Karnovsky I. A., *Advance method of structural analysis book*, Springer Nature, Vancouver 2021.
2.	Russel C., Hibbeler R. C., *Structural Analysis.* 9th edition, Pearson Prentice Hall, New Jersey 2015.
3.	Mau S. T., *Introduction to structural analysis – displacement and force methods*, CRC Press 2012.
4.	McCormac J. C., *Structural Analysis using classical and matrix methods.* John Wiley and Sons Inc. 2007.
Additional literature:	
1.	Coates R. C., Coutie M. G., Kong F. K., *Structural Analysis*, CRC Press 2018.
2.	Williams A., *Structural analysis: in theory and practice*, International Code Council, Oxford 2009.