FACULTY OF CIVIL ENGINEERING

SUBJECT CARD

Name in Polish: **Dynamika**
Name in English: **Dynamics**
Main field of study (if applicable): ***Civil Engineering***
Specialization (if applicable): **Civil Engineering**
Level and form of studies: **~~1st /~~ 2nd level*, full-time ~~/ part-time~~***
Kind of subject: **obligatory ~~/ optional~~ / ~~university-wide~~***
Subject code: **CEB007962**
Group of courses: **~~YES~~ / NO***

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	**15**		**15**		
Number of hours of total student workload (CNPS)	**60**		**30**		
Form of crediting	Examination / ~~crediting with grade~~ *	Examination / crediting with grade *	~~Examination-~~/ crediting with grade *	Examination / crediting with grade *	Examination~~-~~/ crediting with grade *
For group of courses mark (X) final course					
Number of ECTS points	**2**		**1**		
including number of ECTS points for practical (P) classes			**1,0**		
including number of ECTS points for direct teacher-student contact (BK) classes	**0,7**		**0,6**		

*niepotrzebne skreślić

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. The student possesses knowledge of the areas of mathematics and physics necessary for the analysis of dynamics of structures.
2. The student knows the principles of analysis of bar structures statics.
3. The student has the necessary knowledge of structure designing and strength of materials.
4. The student has the necessary knowledge of the dynamics of one-degree-of-freedom systems (ones consisting of mass points, stiff discs and/or deformable bars).

SUBJECT OBJECTIVES

C1. Gaining an in-depth knowledge of dynamic loads and the evaluation of civil engineering structures' vibrations.
C2. Learning the principles of solving the eigenproblem for multiple-degree-of-freedom systems (discrete or discretized).
C3. Learning the principles of solving the problem of harmonic forced vibration for multiple-degree-of-freedom systems(discrete or discretized).
C4. Gaining basic knowledge of designing dynamically loaded structures.

SUBJECT EDUCATIONAL EFFECTS	
Relating to knowledge:	
PEK_W01	The student has an in-depth knowledge of engineering problems in structure dynamics.
PEK_W02	The student knows the principles of analysis of natural vibration of discrete systems and discretized bar structures.
PEK_W03	The student knows the principles of harmonically forced vibrations analysis, using both the direct method and the modal transformation method.
PEK_W04	The student has knowledge of the basic types of exciting vibration of civil engineering structures
Relating to skills:	
PEK_U01	The student can create a discrete dynamic computation model of a bar system.
PEK_U02	The student can formulate equations of motion of discrete bar systems using the Force Method and Displacement Method
PEK_U03	The student can solve eigenproblems of discrete dynamic systems.
PEK_U04	The student can determine the full dynamic load of the structure.
PEK_U05	The student can determine the envelopes of the dynamic cross-section forces under harmonic excitation.
PEK_U06	The student can determine the analytical solution of an equation of motion of a one-degree-of-freedom system in special cases of excitation.
Relating to social competences:	
PEK_K01	The student is conscious of the need for furthering their knowledge of the dynamics of civil engineering structures through ongoing self-study.
PEK_K02	The student is conscious of the possibility that vibration of the designed structures can have negative effects.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec1	Aims, scope and plan of the subject. Overview of the engineering problems in structural dynamics. Dynamic degrees of freedom and generalized coordinates. Continuous and discrete dynamic models of deformable bar structures. Examples of determining the number of dynamic degrees of freedom of discrete bar systems, the degree of static and geometric (kinematic) indeterminacy. Geometric indeterminacy in the dynamic sense.	2
Lec2	Second order Lagrange's equations. Systems of coordinates and their transformations. The energetic balance and the matrix equation of motion of a discrete system. Elastic bonds in discrete bar systems, the definition of the displacement and stiffness matrices. Examples of calculating the displacement matrix in statically determinate and indeterminate systems.	2
Lec3	Examples of calculating the stiffness matrices in geometrically determinate and indeterminate systems. Examples of forming an equation of motion of a discrete system: a beam supporting structure for a rotating motor. Examples of determining the mass matrix and the generalized vector of the exciting forces in discrete bar systems.	2
Lec4	The eigenproblem of a discrete system. Example of analysis of the natural vibration of a simply supported beam with three dynamic degrees of freedom, the eigenforms of the vibration. Free vibration of the discrete system. Damping in civil engineering structures. Models of damping and the force transferred to foundations in discrete systems.	2
Lec5	The kinetostatic method. The principles of designing dynamically excited structures. The state of strain and state of strength. The idea of dynamic envelopes of cross-section forces . Harmonically excited steady-state vibration in discrete systems (direct method). Example of determining the	2

	dynamic envelopes of cross-section forces for a bar system with a discrete mass distribution.	
Lec6	The Orthogonality Priniple of natural vibration, the modal transformation method. Harmonic excitation in a one-degree-of-freedom system. The use of the modal transformation method for analysing harmonically excited steady-state vibration in multi-degree-of-freedom systems. The dynamics of a stiff solid on elastic ground.	2
Lec7	The use of the modal transformation method for analysing harmonic vibration of a block foundation. Special cases of excitation in a one-degree-of-freedom system: inertial excitation and kinematic excitation.	3
	Total hours	**15**

Form of classes - class		**Number of hours**
Cl1		
...		
	Total hours	

Form of classes - laboratory		**Number of hours**
Lab1	Elements of the matrix and vector calculus.	2
Lab2	One-degree-of-freedom systems.	2
Lab3	Arranging the elastic and damping bonds (in parallel, in series and mixed).	2
Lab4	Superposition of vibration. Beating.	2
Lab5 Lab6 Lab7	Discrete systems – beams and frames. The force method and the displacement method. Eigenproblem – eigenfrequency and eigenforms. Harmonically forced vibrations. Dynamic envelopes of the cross-section forces.	7
	Total hours	**15**

Form of classes - project		**Number of hours**
Proj1		
…		
	Total hours	

Form of classes - seminar		**Number of hours**
Sem1		
…		
	Total hours	

TEACHING TOOLS USED	
N1.	classic lecture
N2.	multimedial presentation
N3.	Examples of problem solutioin with the use of computer programs.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F (computer laboratory)	PEK_U01 PEK_U02 PEK_U03 PEK_U04 PEK_U05 PEK_U06	Active participation during class
P (lecture)	PEK_W01-PEK_W04 PEK_U01- PEK_U06 PEK_K01, PEK_K02	Written test – questions on theory and practical problems.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Z. WÓJCICKI, J. GROSEL, Structural Dynamics, WUT (PRINTAP Łódź, Wrocław 2012, http://www.studia.pwr.wroc.pl/materialy/526/civil_engineering.html

[2] Teaching materials, http://www.studies.pwr.wroc.pl/teaching_materials/448/civil_engineering.html

SECONDARY LITERATURE:

[1] J. LANGER, Dynamika budowli, Oficyna Wydawnicza PWr, Wrocław, 1980

[2] T. CHMIELEWSKI, Z. ZEMBATY, Podstawy dynamiki budowli, ARKADY, Warszawa, 1998

[3] M. KLASZTORNY, Mechanika. Statyka. Kinematyka. Dynamika., DWE, Wrocław 2000.

[4] R. LEWANDOWSKI, Dynamika konstrukcji budowlanych, Wyd. Polit. Poznańskiej, Poznań 2006.

[5] Z. OSIŃSKI, Tłumienie drgań, PWN, Warszawa, 1997.

[6] S. KALISKI, Mechanika techniczna, drgania i fale, PWN, Warszawa,1986.

[7] R. GUTOWSKI, W.A. SWIETLICKI, Dynamika i drgania układów dynamicznych, PWN, Warszawa, 1986.

[8] G. RAKOWSKI i in., Mechanika Budowli – ujęcie komputerowe, t.2, Arkady 1992.

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Dynamics
AND EDUCATIONAAL EFFECTS FOR MAIN FIELD OF STUDY ***Civil Engineering***
AND SPECIALIZATION **Civil Engineering**

Subject educational effect	**Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)****	**Subject objectives *****	**Programme content *****	**Teaching tool number *****
Knowledge				
PEK_W01	K2_W01, K2_W03, K2_W04, K2_W05, K2S_CEB_W22	C1, C4	Lec1 do Lec4,	N1-N3
PEK_W02	K2_W04, K2_W05	C2	Lec4-Lec5	N1, N3, N4
PEK_W03	K2_W04, K2_W05	C3, C4	Lec6	N1, N3, N4
PEK_W04	K2_W04, K2_W05	C1	Lec7	N1
Skills				
PEK_U01	K2_U03, K2_U06, K2_U07, K2_U16	C2, C3	Lab1	N1 do N3
PEK_U02	K2_U03, K2_U06	C2, C3	Lab2	N1 do N3
PEK_U03	K2_U03, K2_U06, K2_U07, K2_U09, K2S_CEB_U19	C2	Lab3	N1 do N3
PEK_U04	K2_U03, K2_U05, K2_U06	C1, C3	Lab4	N1 do N3
PEK_U05	K2_U03, K2_U05, K2_U06	C3	Lab5	N1 do N3
PEK_U06	K2_U03, K2_U06	C1	Lab6	N1 do N3
Social competences				
PEK_K01	K2_K01	C1, C4	Lec1 do Lec7 Lab1 do Lab7	N1 do N3
PEK_K02	K2_K02	C1, C4	Lec1 do Lec7 Lab1 do Lab7	N1 do N3

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above