

DOCTORAL COURSE

Department of Doctoral Environmental Studies in Civil Engineering and Architecture

Civil Engineering

Code	Subject	Persons Responsible	semester I	semester II	semester III	semester IV	semester V
			Seminar	Seminar	Seminar	Seminar	Seminar
D-CE 1	<u>English</u>	mgr S. Lipecki / mgr. M. Michalska	2	2	2	2	2
D-CE 2	<u>Continuum Mechanics</u>	dr inż. I. Kreja	2				
D-CE 3	<u>Introduction to Scientific Research</u>	dr Grzegorz Graff	2				
D-CE 4	<u>Presentation of Doctoral Thesis</u>		2				
D-CE 5	<u>Application of Computer Programs in CE</u>	dr hab. inż. P. Kłosowski	2				
D-CE 6	<u>Applied Mathematics</u>	prof. A. Borysowicz	2				
D-CE 7	<u>Methods of Data Analysis</u>	prof. dr hab. inż. Cz. Szmydkowski		2			
D-CE 8	<u>Experimental Methods</u>	dr hab. inż. T. Kucharski		2			
D-CE 9	<u>Modeling in Building Engineering</u>	dr hab. inż. H. Walukiewicz		2			
D-CE 10	<u>Main problems of Contemporary Civil Engineering and Architecture</u>			2			
D-CE 11	<u>Modeling of Materials</u>	prof. J. Tejchman			2		
D-CE 12	<u>Finite Element Method</u>	prof. J. Chróścielewski			<u>2</u>	<u>2</u>	
D-CE 13	<u>Theory of Stability</u>	prof. Cz. Szymczak				2	
D-CE 14	<u>Structures Optymisation Methods</u>	prof. Cz. Szymczak					2
D-CE 15	<u>Rheological Problems – Theory And Applications</u>	dr hab. inż. P. Kłosowski					2
Hours per week:			12	10	6	6	6
Total hours			180	150	90	90	90
Lectures given by specialists from Europe and Poland financed by European Union			10	10	10	10	10
Total hours:			190	160	100	100	100

Subject	English				Code		
	Semester	I	Hours	2	ECTS points		
			l	t	lb	d	
Department	Foreign Languages Department					Assessment	NE
Persons Responsible	mgr S. Lipecki / mgr. M. Michalska					Code	SPNJO

Contents

The classes focus on language for special purposes. In order to give each student the opportunity to learn a foreign language, the department organises classes for various levels of ability: beginners, lower intermediate, intermediate and advanced. Students who wish to improve and perfect their knowledge can attend additional language clubs.

References: _____

Prerequisites _____ Codes: _____

Subject	Continuum Mechanics				Code		
	Semester	I	Hours	2	ECTS points		
			l	t	e	p	
Department	of Structural Mechanics					Assessment	NE
Persons Responsible	Ireneusz Kreja					Code	DSM

Contents

Basis, notation and terminology. Scalars, vectors and tensors.
 Tensor calculus.
 Geometry of deformation. Strains. Strain tensors.
 State of stress. Stress tensors.
 Conservation laws. Energy equations.
 Constitutive relations. Classical models of materials.

References:

- Y. Basar, D. Weichert: „Nonlinear Continuum Mechanics of Solids”, Springer Verlag, Berlin 2000
- Y. C. Fung: „Podstawy Mechaniki Ciała Stałego”, PWN, Warszawa 1969
- E. Green, W. Zerna: ”Theoretical Elasticity”, Clarendon Press, Oxford 1968
- K. D. Hjelmstad: „Fundamentals of Structural Mechanics”, Prentice-Hall Int., London 1997
- G. A. Holzapfel: “Nonlinear Solid Mechanics. A Continuum Approach for Engineering”, John Willey and Sons, Chichester 2000

Prerequisites _____ Codes _____

Subject	Introduction to scientific research				Code	
Semester	I	Hours	2		ECTS points	
			l	t	e	p
Department	of Physics of Electronic Phenomena				Assessment	NE
Persons Responsible	Grzegorz Graff				Code	PEP

Contents

Science and ethics. Scientific publications.
Science and pseudo-science. Community of scientists.
Structure of scientific revolution. Techniques of doing research.
PhD dissertation. Main themes of contemporary philosophy of science.
References:
Prerequisites
Codes

Subject	Presentation of Doctoral Thesis				Code	
Semester	I	Hours	2		ECTS points	
			l	t	e	p
Department	of Structural Mechanics				Assessment	NE
Persons Responsible	Czesław Szymczak				Code	KMB

Contents

References:
Prerequisites
Codes

Subject	Application of computer programs in civil engineering				Code	
Semester	I	Hours	2		ECTS points	
			l	t	e	p
Department	of Structural Mechanics				Assessment	NE
Persons Responsible	Paweł Kłosowski				Code	KMB

Contents

Commercial programs based on the finite element method (MES) and their suitability in designing and scientific research. Programs Robot, MSC.Nastran, MSC.Marc, SAP(NONSAP), ADINA.
Principles of finite elements selection rules of creation of different types of element meshes.
Application of Robot Millennium software for linear analysis of plates and shells.
Presentation of MSC.Marc program application.
References:
Prerequisites
Codes

Subject	Applied Mathematics				Code	
Semester	I	Hours	2		ECTS points	
			l	t	e	p
Department	Mathematics and Physics - UG				Assessment	NE
Persons responsible	Andrzej Borysowicz				Code	KM

Contents

Metric spaces, completeness, $C[a,b]$ - space of the continuous functions, $L(a,b)$ - Lebesgue space.
Banach spaces and it's properties. Boundary linear operators of the Banach spaces and it's norms.
Elements of the spectral theory. Isomorphism and linear maps of the Fredholm type.
Nonlinear operators in the Banach spaces, smoothness and derivative.
Sobolev spaces. Elements of the calculus of the variations.
Bifurcation problem and the implicit function (map) theorem.
Krasnoselski and Krendall-Rabinowitz bifurcation theorems.
Finite-dimension reduction by Lyapunov-Schmidt type for the equations with Fredholm type operators.
References
Rudin Walter, <i>Functional Analysis</i>
L. Lusternik, V. Sobolev, <i>Elements of the Functional Analysis</i>
A. Alexiewicz, <i>Functional Analysis</i>
S. Banach, <i>Theory of the linear operations</i>
T. Kato, <i>Perturbation theory of linear operators</i>
J. Musielak, <i>Introduction to Functional Analysis</i>
Prerequisites
Codes

Subject	English						Code	
	Semester	II	Hours	2			ECTS points	
				l	t	lb	d	
Department	Foreign Languages Department						Assessment	NE
Persons Responsible	mgr S. Lipecki / mgr. M. Michalska						Code	SPNJO

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References: _____

Prerequisites _____ Codes: _____

Subject	Methods of data analysis						Code	
	Semester	II	Hours	2	-	-	ECTS points	
				l	t	e	p	
Department	Atomic Physics and Luminescence						Assessment	
Persons Responsible	Czesław Szmytkowski						Code	APL

Contents

Nature of experiment. The design of experiment: selection of the object of experimentation, comparison of the research methods, sources of uncertainties, optimization of the method, selection of the representative sample. Running the measurements. Analysis and interpretation of results: collection and presentation of data, estimation of true value and its accuracy at direct and complex measurements. Adjustment of observations; least-squares method; correlation and relationship; regression formula. Making and testing of scientific hypothesis; making decision.

References: • Brandt S. "Statistical and Computational Methods in Data Analysis" Springer NY

Prerequisites _____ Codes: _____

Subject	Experimental Methods						Code	
	Semester	II	Hours	2	-	-	ECTS points	
				l	t	e	p	
Department	Mechanics and Material Strength						Assessment	
Persons Responsible	Tomasz Kucharski						Code	MMS

Contents

Presentation of practical application of computer aided technology in engineering calculations and research purposes. Basic knowledge on co-operation with MS-DOS and WINDOWS operating systems. Integrated programming system and the Programming of Engineering Calculation with the use of the MATLAB package and MATHCAD software.

References:	
Prerequisites	Codes

Subject	Modeling in Building Engineering						Code	
	Semester	II	Hours	2	-	-	ECTS points	
				l	t	e	p	
Department	of Structural Mechanics						Assessment	
Persons Responsible	Henryk Walukiewicz						Code	KMB

Contents

References:	
Prerequisites	Codes

Subject	Main problems of Contemporary Civil Engineering and Architecture				Code	
Semester	II	Hours	2	-	-	ECTS points
			l	t	e	p

Department of Structural Mechanics

Persons Responsible

Assessment	
Code	KMB

Contents

References:

Prerequisites Codes

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Subject	English				Code		
	Semester	III	Hours	2	ECTS points		
				l	t	lb	d
Department	Foreign Languages Department				Assessment	NE	
Persons Responsible	mgr S. Lipecki / mgr. M. Michalska				Code	SPNJO	

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Prerequisites _____ Codes: _____

Subject	Modeling of Materials				Code		
	Semester	III	Hours	2	ECTS points		
				l	t	lb	d
Department	of Fundamentals of Building and Material Engineering				Assessment	NE	
Persons Responsible	Jacek Tejchman				Code	PBiM	

Contents

Static and dynamic properties of concrete.
 Discrete lattice beam models for description of crack propagation in concrete and reinforced elements
 Truss models to calculate the bearing capacity of large reinforced and prestressed concrete elements.
 Linear elastic models for concrete and failure criteria for concrete.
 Non-linear elastic and hypo elastic models for concrete.
 Modeling within theory of plasticity, flow rules, plastic relations between stresses and strains.
 Application of the theory of plasticity to describe the metal behavior in complex stress states.
 Properties of soils, failure criteria, elastic models, elasto-plastic models to describe the behavior of soils

References: _____

Prerequisites _____ Codes: _____

Subject	Finite Element Method				Code	
	Semester	3	Hours	2	ECTS points	
				l t e p		
Department	Bridges				Assessment	NE
Persons responsible	Jacek Chróścielewski				Code	KM

Contents

FEM in linear structural analysis: FEM discretization, finite-dimensional approximation.	
Interpolation. Shape functions, stiffness matrix, numerical integration, global equations.	
Elements classification. C^0 isoparametric elements.	
Structure of FEM program – creating own codes. Typical data structure and interpretation of results.	
Low order elements – locking in full integration, uniformly reduced integration, selective reduced integration, control of spurious zero-energy modes.	
Errors and convergence of FEM. Elements classification.	
Linear stability - eigenproblem in stability analysis.	
Dynamics analysis, mass and damping matrices. Free vibration – eigenproblem.	
Direct integration of equations of motion, method of modal superposition, implicit/explicit schemes.	
References	BATHE K.J.: <i>Finite Element Procedures in Engineering Analysis</i> . Englewood Cliffs: Prentice-Hall 1982. ZIENKIEWICZ O.C.: <i>Finite Element Method</i> .
Prerequisites	Codes

Subject	English				Code		
	Semester	IV	Hours	2	ECTS points		
			l	t	lb	d	
Department	Foreign Languages Department					Assessment	NE
Persons Responsible	mgr S. Lipecki / mgr. M. Michalska					Code	SPNJO

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Prerequisites _____ Codes: _____

Subject	Finite elements method II				Code		
	Semester	IV	Hours	2	ECTS points		
			l	t	e	p	
Department	Bridges					Assessment	NE
Persons responsible	Jacek Chróścielewski					Code	KM

Contents

Particular topics of FEM in nonlinear structural analysis.
 Variational principles, total and updated Lagrangian implementations.
 Sources of geometrical and material nonlinearity.
 Incremental technique for solving nonlinear equations of motion, Newton principle, linearization.
 Stability analysis, static and kinetic stability criteria, loss of stability, classification of critical points.
 Equilibrium paths, load, displacement and arch parameter control. Solutions convergence.
 Nonlinear equations of motion - direct integration.

References BATHE K.J.: *Finite Element Procedures in Engineering Analysis*. Englewood Cliffs: Prentice-Hall 1982.

Prerequisites _____ Codes: _____

Subject	Theory of Stability				Code	
	Semester	IV	Hours	2	ECTS points	
				l t e p		
Department	Structural Mechanics				Assessment	E
Persons Responsible	Czesław Szymczak				Code	

Contents

Introduction, historical outline			
Structural stability and bifurcation			
Structural stability and stability of motion			
Principles of stability of motion, Lapunov's theorem of stability			
Stability problems of structures			
Kinetic criterion of stability			
Static criterion of stability			
Energy methods			
Outline of catastrophe theory			
References: Thompson J. M. T., Hunt G. W.: A General Theory of Stability, Wiley&Sons, 1973. Waszczyszyn Z., Cichoń C., Radwańska M.: Stability of Structures by Finite Element Methods, Elsevier, 1994.			
Prerequisites	Codes		

Subject	English				Code	
	Semester	V	Hours	2	ECTS points	
			l	t	lb	d
Department	Foreign Languages Department				Assessment	NE
Persons Responsible	mgr S. Lipecki / mgr. M. Michalska				Code	SPNJO

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References: _____

Prerequisites _____ Codes: _____

Subject	Structural Optimization Methods				Code	
	Semester	V	Hours	2	ECTS points	
			l	t	e	p
Department	Structural Mechanics				Assessment	E
Persons Responsible	Czesław Szymczak				Code	

Contents

Formulation of optimization problems, criteria, design variables and constraints

Classification of optimization problems, multi- and one criteria methods

Solution of optimization problems

Graphical and analytical methods

Nonlinear programming methods

Linear programming

Dynamic programming

Application of variation calculus

Non sequential methods, genetic algorithms, neural sets

References: Szymczak C.: Elementy teorii projektowania, PWN 1988
 Goldberg D. E.: Algorytmy genetyczne i ich zastosowania, WNT, 1995
 Żurada J., Barski m., Jedruch W.: Sztuczne sieci neuronowe, PWN 1996.

Prerequisites _____ Codes: _____

Subject	Rheological Problems – Theory And Applications				Code	
Semester	V	Hours	2		ECTS points	
			l	t	e	p
Department	of Structural Mechanics				Assessment	NE
Persons Responsible	Paweł Kłosowski				Code	KMB

Contents

Introduction into theory of rheological problems.				
Viscoelastic versus viscoplastic constitutive models.				
Viscoelastic constitutive models (linear and non-linear variants).				
Temperature influence and damage in constitutive equations.				
Examples of application of rheological constitutive models.				
Application of constitutive models in the structures analysis by the finite element method.				
References:				
Prerequisites	Codes			