STUDY MODULE DESCRIPTION FORM

Name of the module/subject		Code
Numerical Analysis		**1010102121010111980**
Field of study	Profile of study (general academic, practical)	Year /Semester
Civil Engineering Second-cycle Studies	**(brak)**	**1 / 2**
Elective path/specialty	Subject offered in:	Course (compulsory, elective)
Structural Engineering	**Polish**	**obligatory**
Cycle of study:	Form of study (full-time,part-time)	
Second-cycle studies	**full-time**	
No. of hours		No. of credits
Lecture: **15** Classes: **30** Laboratory: **15** Project/seminars: **-**		**3**
Status of the course in the study program (Basic, major, other)	(university-wide, from another field)	
(brak)	**(brak)**	
Education areas and fields of science and art		ECTS distribution (number and %)
technical sciences		**3 100%**
Technical sciences		**3 100%**

Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Basics of partial differential equations, basics of nonlinear structural mechanics, finite element method ? Plain stress, plane strain, 3d, shells, geometrical nonlinearity, buckling, linear dynamic, nonlinear :explicit and implicit solution of the equations of motion
2	**Skills**	Solving static and dynamic linear and nonlinear problems by the finite element method
3	**Social competencies**	Social competencies

Assumptions and objectives of the course:

A goal is to learn and practice using the finite element method in solving complex nonlinear structural problems in civil engineering

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. The finite difference method applied to solving nonlinear partial differential equations - [K_W01, K_W03]
2. The finite element method, its implicit and explicit approaches, applied to solving nonlinear structural problems - [K_W03, K_W01]
3. Advanced numerical methods applied to nonlinear static and dynamic problems, contact problems, buckling and post-buckling stability analysis, basics of computational fluid dynamics. - [K_W04]

Skills:

1. Solving advanced practical problems by numerical methods - [K_U04, K_U06]
2. Modeling by the finite element method advanced boundary and initial-boundary problems - [K_U06, K_U04]
3. Usage of a commercial finite element program to practical complex engineering problems - [K_U18]

Social competencies:

1. Student understands needs of cooperation in solving theoretical and practical engineering problems - [K_K03]
2. Student is aware of needs for affordable share their expertise in the field of computationa mechanics - [K_K05]
3. Student sees needs for a systematic deepening and broadening its competence - [K_K01]

Assessment methods of study outcomes

Course grading: Lectures - end-term exam, Laboratory - evaluation of the exercises and the final test

Course description

Physical nonlinearity. Constitutive modelling in civil engineering (for concrete, steel, gum, ceramic, glass, wood). The coupling of the experiments and computer simulations in description of the dynamic behaviour of the material and structure in high strain rates condition. Using of the computer simulation to describe the behaviour of the structure for unique loadings as impacts, explosions and floods. The coupling problems (thermo-mechanical) ? the behaviour of the structure at elevated temperatures (fire). The contact conditions. The basics of the fluid mechanics ? interaction of the fluid and structure.

Basic bibliography:

1. T. Łodygowski, W. Kąkol, Metoda elementów skończonych w wybranych zagadnieniach mechaniki konstrukcji inżynierskich, Skrypt PP, 1994, Nr 1779
2. T. Belytschko, W. K. Liu, B. Moran, Nonlinear Finite Elements for Continua and Structures, John Wiley and Sons, 2000
3. J.C. Simo, T. J. R. Hughes, Computational Inelasticity, Springer, 1998
4. T. Jankowiak, Kryteria zniszczenia betonu poddanego obciążeniom quasi-statycznym i dynamicznym, Monografia, Wydawnictwo Politechniki Poznańskiej, 2011, p. 138
5. T. Jankowiak, Wykorzystanie metod eksperymentalnych I symulacji komputerowych do określania właściwości materiałów przy dużej prędkości deformacji, Monografia, Wydawnictwo Politechniki Poznańskiej, 2016, p. 161

Additional bibliography:

1. J.N. Reddy, An Introduction to Nonlinear Finite Element Analysis, Oxford University Press, 2004
2. O.C.Zienkiewicz, R.L.Taylor, Finite Element Method, Elsevier 2005

Result of average student's workload

Activity	Time (working hours)
1. Lectures	15
2. Classes	15
3. Labs	15
4. Final exam	15

Student's workload

Source of workload	hours	ECTS
Total workload	75	3
Contact hours	60	2
Practical activities	40	2