COMPUTATIONAL METHODS

Course code:	**11.3-WILŚ- BUD- MEO- IA06**
Type of course:	compulsory
Entry requirements:	basic knowledge of computing, mathematical analysis, ordinary differential equations, strength of materials and structural mechanics, programming languages (Fortran or C++, etc.)
Language of instruction:	Polish
Director of studies:	prof. dr hab. inż. Mieczysław Kuczma Department of Structural Mechanics
Name of lecturer:	prof. dr hab. inż. Mieczysław Kuczma dr inż. Krzysztof Kula dr inż. Tomasz Socha dr inż. Waldemar Szajna dr inż. Krystyna Urbańska mgr inż. Arkadiusz Denisiewicz mgr inż. Paulina Lechocka

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	30	2	IV	Grade	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	10	1	IV	Grade	
Class					
Laboratory	20	2		Grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

Lecture

Mathematical modelling of engineering problems. Direct and iterative methods for solving a linear system of algebraic equations. Convergence criteria for Jacobi's iterative method. Approximation and interpolation of functions. Numerical differentiation and integration. Boundary value problem for ordinary differential equations. Local (differential) and global (integral) formulations for boundary value problems in mechanics. Classical (strong) and generalized (weak) solutions of an ordinary differential equation. Approximate methods for solving problems in mechanics (Ritz and Galerkin approaches).The finite element method (FEM). General steps of the FEM procedure. Selection rules for FEM shape functions. Finite elements for one-dimensional problems (structural elements: bar, beam). The states of plane stress or plane strain – fundamental equations in matrix form and types of finite elements for two-dimensional problems. Isoparametric finite elements. Convergence and error analysis of the FEM solution – numerical examples. Initial boundary value problem of heat conduction. The finite difference method. Formulation of difference equations and boundary conditions. Stability of the space-time approximation – numerical examples.

Laboratory

1. *System of linear equations.*
2. *Finite element method for a one-dimensional problem.*
3. *Finite element method for a two-dimensional problem (plane state of stress).*

LEARNING OUTCOMES:

Competence and skill (i) to understand the essence of approximation and interpolation of functions and global vs. local formulations of boundary value problems in mechanics, (ii) to understand the fundamentals of finite element method, (iii) to write simple computer programs and to use some advanced commercial computer programs for analysis of boundary value problems in mechanics of materials and structures (Algor, Abaqus).

ASSESSMENT CRITERIA:

Lecture – *to receive a credit for final test.*

Project – *to receive a credit for all projects and tests.*

RECOMMENDED READING:

1. Bąk R., Burczyński T.: Wytrzymałość materiałów z elementami ujęcia komputerowego. WNT, Warszawa 2001.
   http://www.mes.polsl.gliwice.pl
2. Fortuna Z., Macukow B., Wąsowski J.: Metody numeryczne, Warszawa 2001.
3. Łodygowski T., Kakol W., Metoda elementów skończonych w wybranych zagadnieniach mechaniki konstrukcji inżynierskich, Wyd. PP, Poznań 1991.
   http://www.ikb.poznan.pl/zaklady/komp/dydaktyka/materialy/skrypt.html
4. Rakowski G., Kacprzyk Z.: Metoda elementów skończonych w mechanice konstrukcji, Wyd. PW, Warszawa 2005.
5. Sobieski W., Edi 3.1 - zintegrowane środowisko programistyczne dla programujących w języku Fortran, Olsztyn 2008.
   http://www.uwm.edu.pl/edu/sobieski/

OPTIONAL READING:

6. Dahlquist G., Bjoerck A., Numerical methods in Scientific Computing, vol. I, SIAM, Philadelphia 2008.
7. Kącki E.: Równania różniczkowe cząstkowe w zagadnieniach fizyki i techniki, WNT, Warszawa 1989.
8. Kincaid D., Cheney W.: Analiza numeryczna, WNT, Warszawa 2006.