Numerical methods

Faculty of	**Mechanical and Power Engineering**
Name in English	**Numerical methods**
Name in Polish	**Metody numeryczne**
Main field of study	**Power Engineering**
Specialization	**-**
Level of studies	**II level**
Form of studies	**full-time**
Kind of subject	**optional-specialization**
Subject code	**W09ENG-SM2346**
Group of courses	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	50		50		
Form of crediting	Egzamin		Zaliczenie		
For group of courses mark final course with (X)					
Number of ECTS points	2		2		
including number of ECTS points for practical (P) classes			2		
including number of ECTS points for direct teacher-student contact (BU) classes	0,84		1,36		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.	Fundamentals of mathematical analysis, algebra and geometry in mathematics
2.	Mathematical calculus and syntax used for computer based calculation
3.	Basic knowledge of physics phenomena

SUBJECT OBJECTIVES

C1	Acquisition of basic numerical methods knowledge essential for solving engineering problems. Improving the state of knowledge in the field of computer-based calculations.
C2	Obtaining skill of creating programs utilizing basic algorithms of numerical methods with use of approximation, interpolation, numerical integration and differentiation, solving nonlinear algebraic equations and differential equations.
C3	Developing the ability to use the selected numerical techniques to process measurement data and solve real-life engineering problems.

SUBJECT LEARNING OUTCOMES

relating to knowledge:	
PEU_W01	Understanding the numerical calculations process based on a finite digit representation and accuracy related problems.
PEU_W02	Understanding the concept of numerical interpolation and ability to construct interpolation polynomials and spline functions. Ability to estimate the interpolation error.
PEU_W03	Knowledge of data processing with least square approximation method for any set of basis functions.

PEU_W04	Knowledge of numerical integration and differentiation methods. Knowledge of error source and methods of its estimation.
PEU_W05	Knowledge of methods for solving non-linear equations and systems of linear equations.
relating to skills:	
PEU_U01	Use of MATLAB/Octave built in functions and basic programming operations. Creating plots and user defined functions.
PEU_U02	For a given set of points student know how to find an interpolating polynomial or create spline function
PEU_U03	Student is able to determine the integral value with use of Midpoint, Trapezoid or Simpson method. Based on finite-difference method student is able to determine the value of the derivative.
PEU_U04	With the use of Bisection, Secants, Newton or Fixed-Point method, student can solve non-linear equation
PEU_U05	Solving a system of linear algebraic equations using an algorithm implemented in MATALB
relating to social competences:	
PEU_K01	

PROGRAMME CONTENT

Form of classes - lecture		Number of hours
Wy1	Introduction. Floating point mathematical operations. Precision of arithmetics. Basic information about MATLAB.	1
Wy2-Wy4	Basic operations in MATLAB – Vectors and arrays, Conditional statements, preparation of 2D and 3D plots, *For* and *while* loops, User defined functions.	6
Wy5	Interpolation – Newtons and Lagrange Method for finding interpolating polynomial. Spline functions.	2
Wy6	Least square approximation – derivation of approximation function for any set of basis functions. Approximation with use of non-linear functions.	2
Wy7	Solving non-linear equations and systems of linear equations.	2
Wy8	Numerical integration and differentiation – Midpoint, Trapezoid and Simpson integration methods. Approximation of derivative with finite-difference method.	2
Suma godzin		15

laboratory		Number of hours
La1	Arithmetic operations, familiarization with the MATLAB environment	2
La2	Vectors and arrays	2
La3	Operations on vectors and arrays	2
La4	Conditional statements, preparation of 2D and 3D plots	2
La5	*For* and *while* loops	2
La6	Test of knowledge of the basics of programming in the MATLAB environment	2
La7	Interpolation using MATLAB functions, Vandermonde and Lagrange method	2
La8	Newton's interpolation. Interpolation error.	2
La9	Spline functions.	2
La10	Least square approximation.	2
La11	Solving non-linear equations - Newton's method, secants method	2
La12	Solving non-linear equations - fixed point iteration method, bisection method	2
La13	Solving system of linear equations. Gauss and LU decomposition method.	2
La14	Numerical integration – midpoint and trapezoid method, Simpson's method, Richardson's extrapolation.	2
La15	Numerical differentiation - finite differences method	2
Suma godzin		30

TEACHING TOOLS USED	
N1	Traditional lecture using multimedia presentation
N2	Individual work - self-study based on supervisor materials, application books, code samples and examples.
N3	Laboratory work work - solving problem lists during laboratory classes
N4	Individual work – solving selected engineering problem and presentation of results in report form

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F– forming (during semester), C– concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEU_U01, PEU_W01	Basic matlab knowledge test. (La6)
F2-F5	PEU_U02- PEU_U05	Reports, laboratory entry tests
F6-F10	PEU_W01- PEU_W05	Reports, laboratory entry tests, partial tests during lecture.

PRIMARY AND SECONDARY LITERATURE

Primary literature	
1	A. Gilat, *MATLAB: An Introduction with Applications*, John Wiley & Sons, Inc., 2010
2	A. Gilat, *Numerical Methods for Engineers and Scientists. An Introduction with Applications using MATLAB*, John Wiley & Sons, Inc., 2014
3	D. Kincaid, W. Cheney, *Numerical Analysis. Mathematics of Scientific Computing",* Wadsworth, 2002
5	G. Dahlquist, A. Bjorck, *Numerical Methods in Scientific Computing .vol.* I, SIAM, 2008
6	A. Quarteroni, F. Saleri, *Scientific Computing with Matlab and Octave*, Springer , 2006
Secondary literaturę	
1	J. Kiusalaas , *Numerical Methods in Engineering with Matlab*, Cambridge, 2005.
2	J. H. Mathews, K. D. Fink, *Numerical Methods Using Matlab*,Prentice Hall, 1999
3	G.W. Recktenwald, *Numerical methods with MATLAB - implementations and applications*, Prentice Hall Inc. 2000, New Jersey

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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