

FACULTY: Computer Science &amp; Management..... / DEPARTMENT.....

**SUBJECT CARD****Name in Polish ...Metody Numeryczne.....****Name in English ...Numerical Methods.....****Main field of study (if applicable): Computer Science.....****Specialization (if applicable): .....****Level and form of studies: 1st level, full-time****Kind of subject: optional****Subject code ...INZ0292Wc****Group of courses :YES**

|   | Lecture              | Classes              | Laboratory | Project | Seminar |
|---|----------------------|----------------------|------------|---------|---------|
| Number of hours of organized classes in University (ZZU)                        | 30                   | 30                   |            |         |         |
| Number of hours of total student workload (CNPS)                                | 60                   | 90                   |            |         |         |
| Form of crediting   | crediting with grade | crediting with grade |            |         |         |
| For group of courses mark (X) final course                                      | X                    |                      |            |         |         |
| Number of ECTS points   | 2                    | 3                    |            |         |         |
| including number of ECTS points for practical (P) classes                       |                      | 2                    |            |         |         |
| including number of ECTS points for direct teacher-student contact (BK) classes | 1,2                  | 1,8                  |            |         |         |

\*delete as applicable

**PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES**

1. Mathematical Analysis
2. Linear Algebra

**SUBJECT OBJECTIVES**

- C1 Acquisition of knowledge about dealing with Approximations and evaluation of Error Bounds.  
 C2 Acquisition of knowledge about Interpolation and Interpolating Polynomials.  
 C3 Acquisition of knowledge about methods of Numerical Integration  
 C4 Acquisition of knowledge about methods of Numerical Differentiation  
 C5 Acquisition of knowledge about methods of solving Nonlinear Equations  
 C6 Acquisition of knowledge about methods of solving Sets of Linear Equations  
 C7 Acquisition of knowledge about numerical methods of Matrix Inversion and finding Determinants  
 C8 Acquisition of knowledge about methods of solving Sets of Nonlinear Equations  
 C9 Acquisition of knowledge about numerical calculation of Eigenvalues & Eigenvectors  
 C10 Acquisition of knowledge about Least Square Approximation of Functions  
 C11 Acquisition of knowledge about Fitting Data with a Cubic Spline  
 C12 Acquisition of knowledge about Numerical Solution of Ordinary Differential Equations  
 C13 Development of skill of handling Approximations and evaluation of Error Bounds.  
 C14 Development of skill of finding Interpolating Polynomials  
 C15 Development of skill of using methods of Numerical Integration  
 C16 Development of skill of using methods of Numerical Differentiation  
 C17 Development of skill of using methods of solving Nonlinear Equations  
 C18 Development of skill of using methods of solving Sets of Linear Equations

C19 Development of skill of using numerical methods of Matrix Inversion and finding Determinants  
 C20 Development of skill of using methods of solving Sets of Nonlinear Equations  
 C21 Development of skill of using numerical calculation of Eigenvalues & Eigenvectors  
 C22 Development of skill of using methods for Least Square Approximation of Functions  
 C23 Development of skill of using methods of Fitting Data with a Cubic Spline  
 C24 Development of skill of using methods of Numerical Solution of Ordinary Differential Equations

### SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK\_W01 Knows basic definitions of Approximations and evaluation of Error Bounds  
 PEK\_W02 Knows basic definitions of Interpolation and Interpolating Polynomials  
 PEK\_W03 Knows basic methods of Numerical Integration  
 PEK\_W04 Knows basic methods of Numerical Differentiation  
 PEK\_W05 Knows basic methods of solving Nonlinear Equations  
 PEK\_W06 Knows methods of solving Sets of Linear Equations  
 PEK\_W07 Knows numerical methods of Matrix Inversion and finding Determinants  
 PEK\_W08 Knows basic methods of solving Sets of Nonlinear Equations  
 PEK\_W09 Knows methods of numerical calculation of Eigenvalues & Eigenvectors  
 PEK\_W10 Knows methods for Least Square Approximation of Functions  
 PEK\_W11 Knows methods of Fitting Data with a Cubic Spline  
 PEK\_W12 Knows basic methods of Numerical Solution of Ordinary Differential Equations

relating to skills:

PEK\_U01 Can evaluate Errors and Error Bounds  
 PEK\_U02 Can find various Interpolating Polynomials  
 PEK\_U03 Can use basic methods of Numerical Integration  
 PEK\_U04 Can use basic methods of Numerical Differentiation  
 PEK\_U05 Can use basic methods of solving Nonlinear Equations  
 PEK\_U06 Can solve Sets of Linear Equations  
 PEK\_U07 Can use numerical methods of Matrix Inversion and finding Determinants  
 PEK\_U08 Can use basic methods of solving Sets of Nonlinear Equations  
 PEK\_U09 Can calculate numerically Eigenvalues & Eigenvectors of a matrix  
 PEK\_U10 Can find Least Square Approximations of Functions  
 PEK\_U11 Can use methods of Fitting Data with a Cubic Spline  
 PEK\_U12 Can use basic methods of Numerical Solution of Ordinary Differential Equations

relating to social competences:

PEK\_K01 Understands the need to use numerical methods in science and engineering.

### PROGRAMME CONTENT

| Form of classes - lecture |  | Number of hours |
|---------------------------|--|-----------------|
| Lec 1                     | Introduction. Errors. Error bounds. Accuracy | 2               |

| Lec 2                   | Interpolation Polynomials                                       | 2               |
|-------------------------|---|-----------------|
| Lec 3                   | Numerical Integration I (Newton-Cotes formulas)                 | 2               |
| Lec 4                   | Numerical Integration II (Gauss, Adam & Milne formulas)         | 2               |
| Lec 5                   | Numerical Differentiation                                       | 2               |
| Lec 6                   | Solution of Nonlinear Equations I                               | 2               |
| Lec 7                   | Solution of Nonlinear Equations II                              | 2               |
| Lec 8.                  | Solving Sets of Linear Equations                                | 2               |
| Lec 9                   | Determinant of a Matrix. Matrix Inversion                       | 2               |
| Lec 10                  | Sets of Nonlinear Equations                                     | 2               |
| Lec 11                  | Numerical Calculation of Eigenvalues & Eigenvectors             | 2               |
| Lec 12                  | Least Square Approximation of Functions                         | 2               |
| Lec 13                  | Fitting Data with a Cubic Spline                                | 2               |
| Lec 14                  | Numerical Solution of Ordinary Differential Equations I         | 2               |
| Lec 15                  | Numerical Solution of Ordinary Differential Equations I         | 2               |
|                         | Total hours   | 30              |
| Form of classes - class |   | Number of hours |
| Cl 1                    | Calculation of Errors, Errors Bounds, Accuracy considerations   | 2               |
| Cl 2                    | Forming Difference Tables and Interpolation Polynomials         | 2               |
| Cl 3                    | Practical use of Simpson's and other Newton-Coates Formulas     | 2               |
| Cl 4                    | Practical use of Gauss, Adam and Milne methods                  | 2               |
| Cl 5                    | Finding Function Derivatives from Difference Tables             | 2               |
| Cl 6                    | Solving Nonlinear Equations by Halving & Other Methods          | 2               |
| Cl 7                    | Solving Nonlinear Equations by Newton's & Iteration Methods     | 2               |
| Cl 8                    | Practical Use of Gauss-Seidel & Iteration Methods               | 2               |
| Cl 9                    | Practical Methods for Finding Determinants and Matrix Inversion | 2               |
| Cl 10                   | Iteration & Newton Methods for Nonlinear Equations              | 2               |
| Cl 11                   | Practical Calculation of Eigenvalues & Eigenvectors             | 2               |
| Cl 12                   | Approximation of Functions by Various Polynomials               | 2               |
| Cl 13                   | Practical Use and Application of Cubic Splines                  | 2               |
| Cl 14                   | Practical Solving of Ordinary Differential Equations I          | 2               |
| Cl 15                   | Practical Solving of Ordinary Differential Equations II         | 2               |
|                         | Total Hours   | 30              |

| TEACHING TOOLS USED                                 |  |  |
|---|--|--|
| N1. Traditional lecture using board/video projector |  |  |
| N2. Tutorial classes                                |  |  |
| N3. Consultations                                   |  |  |
| N4. Student's home work                             |  |  |

#### 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 |
|--|--|--|
| F1   | PEK_U01... PEK_U12                       | Oral answers, problem solving on board           |
| F2   | PEK_W01... PEK_W12                       | Attendance & activity during classes             |
| F3   | PEK_U01... PEK_U12<br>PEK_W01... PEK_W12 | Written test                                     |
| $P = 0,3 * F1 + 0,2 * F2 + 0,5 * F3$   |  |  |

#### PRIMARY AND SECONDARY LITERATURE

##### **PRIMARY LITERATURE:**

- [1] Conte S.C., Carl de Boor, Elementary Numerical Analysis – an algorithmic approach, McGraw-Hill Book Company, New York, 1980
- [2] Hoffman Joe D., Numerical Methods for Engineers and Scientists, , McGraw-Hill Book Company, New York, 1992, (Marcel Dekker, Inc. 2001)

##### **SECONDARY LITERATURE:**

- [1] Won Young Yang, Wenwu Cao, Tae-Sang Chung, John Morris, Applied Numerical Methods using MATLAB, John Wiley & Sons

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

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR  
SUBJECT

.....**Numerical Methods**.....  
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY  
.....Computer Science.....

| 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*** |
|------------------------------|---|-----------------------|----------------------|-------------------------|
| <b>PEK_W01 (knowledge)</b>   | K1 INF_W01  | C1                    | Lec 1                | N1, N3, N4              |
| <b>PEK_W02</b>               | K1 INF_W01  | C2                    | Lec 2                | N1, N3, N4              |
| <b>PEK_W03</b>               | K1 INF_W01  | C3                    | Lec 3, Lec4          | N1, N3, N4              |
| <b>PEK_W04</b>               | K1 INF_W01  | C4                    | Lec 5                | N1, N3, N4              |
| <b>PEK_W05</b>               | K1 INF_W01  | C5                    | Lec 6, Lec 7         | N1, N3, N4              |
| <b>PEK_W06</b>               | K1 INF_W01  | C6                    | Lec 8                | N1, N3, N4              |
| <b>PEK_W07</b>               | K1 INF_W01  | C7                    | Lec 9                | N1, N3, N4              |
| <b>PEK_W08</b>               | K1 INF_W01  | C8                    | Lec 10               | N1, N3, N4              |
| <b>PEK_W09</b>               | K1 INF_W01  | C9                    | Lec 11               | N1, N3, N4              |
| <b>PEK_W10</b>               | K1 INF_W01  | C10                   | Lec 12               | N1, N3, N4              |
| <b>PEK_W11</b>               | K1 INF_W01  | C11                   | Lec 13               | N1, N3, N4              |
| <b>PEK_W12</b>               | K1 INF_W01  | C12                   | Lec 14, Lec15        | N2, N3, N4              |
| <b>PEK_U01 (skills)</b>      | K1 INF_W06  | C13                   | Cl 1                 | N2, N3, N4              |
| <b>PEK_U02</b>               | K1 INF_W06  | C14                   | Cl 2                 | N2, N3, N4              |
| <b>PEK_U03</b>               | K1 INF_W06  | C15                   | Cl 3, Cl 4           | N2, N3, N4              |
| <b>PEK_U04</b>               | K1 INF_W06  | C16                   | Cl 5                 | N2, N3, N4              |
| <b>PEK_U05</b>               | K1 INF_W06  | C17                   | Cl 6, Cl 7           | N2, N3, N4              |
| <b>PEK_U06</b>               | K1 INF_W06  | C18                   | Cl 8                 | N2, N3, N4              |
| <b>PEK_U07</b>               | K1 INF_W06  | C19                   | Cl 9                 | N2, N3, N4              |
| <b>PEK_U08</b>               | K1 INF_W06  | C20                   | Cl 10                | N2, N3, N4              |
| <b>PEK_U09</b>               | K1 INF_W06  | C21                   | Cl 11                | N2, N3, N4              |
| <b>PEK_U10</b>               | K1 INF_W06  | C22                   | Cl 12                | N2, N3, N4              |
| <b>PEK_U11</b>               | K1 INF_W06  | C23                   | Cl 13                | N2, N3, N4              |
| <b>PEK_U12</b>               | K1 INF_W06  | C24                   | Cl 14, Cl 15         | N2, N3, N4              |
| <b>PEK_K01 (competences)</b> | K1 INF_W01, K1 INF_W06  | C1...C24              | Lec1..15, Cl1...15   | N1,N2, N3, N4           |

\*\* - enter symbols for main-field-of-study/specialization educational effects

\*\*\* - from table above