

MODULE INFORMATION SHEET

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| Name of Module Unit | Computational Methods in Environmental Engineering |
| Name in polish language | Metody obliczeniowe w inżynierii środowiska |
| Module type | compulsory / elective |
| Form of studying | full-time day courses |
| Level of study | graduate course (M.Sc. level) |
| Type of study (for extra-mural courses) | - |
| Programme | Environmental Engineering |
| Speciality | Environment Protection Engineering |
| Responsible department | Dept. of Informatics and Environment Quality Research |
| Responsible person | dr inż. Wiktor Treichel |

| Semester | Lectures(E) | Tutorials | Laboratory | Computer Exercises | Projects | ECTS |
|----------|-------------|-----------|------------|--------------------|----------|------|
| 1 | 30E | | | 15 | | 4 |

Learning outcomes (knowledge, skills, competences)

The objective of this course is to deliver basic knowledge of numerical methods applied to environmental problems.

On successful completion of this course student should:

- have knowledge of fundamental methods of numerical analysis,
- know how to apply different methods to particular environmental problems.

Computer assignments using Matlab and Excel give the students an opportunity to practice their skills at scientific programming and computer-based problem solving.

Competences: confirmed ability of applying knowledge in particular problems and applications.

Prerequisites

Mathematics – Algebra+Calculus, Physics I and II, Information Technology, Informatics

Rules for integrated grade setting

60% (examination grade) + 40% (computer exercises grade)

Recommended readings

1. Kincaid D., Cheney W. - Numerical Analysis. Mathematics of Scientific Computing, Thomson Learning Inc. 2002
2. Mathews J. H., Fink K. D. – Numerical Methods using Matlab, Pearson Education Inc., 2004
3. Holzbecher E. – Environmental Modeling using Matlab, Springer Verlag 2007
4. Cutlip M. B., Shacham M. – Problem Solving in Chemical and Biochemical Engineering with Polymath, Excel and Matlab, (second edition), Pearson Education Inc., 2008

Contents of lectures (syllabus)

| | Topics | Time (hrs.) | Scope (S / Ex) |
|--------------|---|-------------|----------------|
| 1 | Basic mathematical tools in computational methods, review of calculus, error analysis | 2 | S |
| 2 | Solution of nonlinear equations. Bisection, Newton-Raphson and secant methods. Fluid mechanics examples. | 4 | S |
| 3 | Solution of linear equation systems, Gaussian elimination and iterative methods. | 4 | S |
| 4 | Interpolation and polynomial approximation | 2 | S |
| 5 | Curve fitting, least-square method, estimation of parameters in environmental models | 2 | S |
| 6 | Numerical differentiation and numerical integration | 2 | S |
| 7 | Numerical solution of ordinary differential equation and systems of equations. Euler's method. Runge-Kutta methods. | 4 | S |
| 8 | Numerical solution of partial differential equations. Parabolic, hyperbolic and elliptic equations. Implicit and explicit methods. Finite-difference method. Introduction to finite-element method. | 6 | S |
| 9 | Introduction to numerical optimization. Minimization of a function of one variable. Linear and nonlinear programming. | 4 | Ex |
| Total | | 30 | hours |

S – topics listed in the legal study programme standards from 12.07.2007

Ex – extended topics

Lecturers

dr inż. Wiktor Treichel

Assessment method

Written exam

Contents of computer exercises

| | Topics | Time (hrs.) | Scope (S / Ex) |
|--------------|---|-------------|----------------|
| 1 | Introduction to problem solving using mathematical software (Matlab, Excel) | 1 | S |
| 2 | Solving nonlinear equations. | 2 | S |
| 3 | Solving systems of linear equations. | 1 | S |
| 4 | Interpolation of data and estimation of parameters in environmental models. | 2 | S |
| 5 | Examples of ordinary differential equations | 3 | S |
| 6 | Examples of partial differential equations in 1D and 2D | 3 | S |
| 7 | Numerical optimization | 3 | Ex |
| Total | | 15 | hours |

S – topics listed in the legal study programme standards from 12.07.2007

Ex – extended topics

Persons responsible for computer exercises

dr inż. Wiktor Treichel

Assessment method for computer exercises

Class participation, timely realization of assigned tasks