# SUBJECT DATASHEET

## I. SUBJECT SPECIFICATION

### 1 BASIC DATA

*1.1 Title*

**NUMERICAL METHODS**

*1.2 Code*

**BMEEOFTMK51**

*1.3 Type*

Module with contact hours

*1.4 Contact hours*

| type | hours/week |
|---|---|
| laboratory practices | 3 |

*1.5 Evaluation*

midterm grade

*1.6 Credits*

4

*1.7 Coordinator*


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title: assistant professor
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*1.8 Department*

Department of Geodesy and Surveying (http://www.epito.bme.hu/department-of-geodesy-and-surveying?language=en)

*1.9 Website*

http://www.epito.bme.hu/BMEEOFTMK51

*1.10 Language of instruction*

Hungarian and English

*1.11 Curriculum requirements*

Compulsory in the Structural engineering (MSc), Infrastructure engineering (MSc), Geoinformatics engineering (MSc) program

*1.12 Prerequisites*

Exclusive subjects (cannot register to subject if any of the subjects below has been completed)
BMEEOFTMKT2

*1.13 Effective date*

September 1, 2017.

## 2 OBJECTIVES AND LEARNING OUTCOMES

### *2.1 Objectives*

The aim of this course is that students learn and apply skill level at solving engineering problems numerically on computers, as well as to introduce the basics of Building Information Modelling (BIM). At the beginning of the semester BIM systems and their application opportunities are introduced, later the principles of the most relevant numerical techniques including their advantages, disadvantages and applicability are presented during laboratory practices. Students may learn and apply mathematical procedures suitable for solving and visualizing technical problems on computer practices. A further purpose of this course is to prepare the students for later independent research.

### *2.2 Learning outcomes*

Upon successful completion of this subject, the student:

A. Knowledge
   1. Knows the principles of Building Information Modelling (BIM)
   2. Knows the application opportunities of BIM
   3. Has a skill level knowledge of a mathematical environment
   4. Knows the basic commands of a mathematical environment including procedures, loops, branching, visualization opportunities, text data reading and writing possibilities
   5. Can distinguish the different computation errors
   6. Knows methods for solving system of linear equations
   7. Understands the methods for finding the roots of system of non-linear equations
   8. Is aware of the difference between the methods of interpolation and regression
   9. Has a general knowledge of optimization methods
   10. Is informed regarding various numerical derivation and integration procedures
   11. Knows several methods for solving initial and boundary value problems in case of ordinary differential equation

B. Skills
   1. Able to skillfully use a mathematical environment to solve engineering problems
   2. Able to interpret the upcoming error/warning messages and to fix the specified errors
   3. Able to knowingly use the software documentation, using which can find the necessary commands, interprets the algorithms and parameters used by the commands
   4. Able to load text data into a mathematical environment
   5. Routinely produce charts in a mathematical environment, and modifies them in line with expectations.
   6. Able to choose the proper algorithm for the specific problem
   7. Able to fit measurement data with an interpolating or regression curve/surface
   8. Able to skillfully solve systems of linear or non-linear equations
   9. Able to determine the local/global extremas of a given function/curve/surface
   10. Able to differentiate/integrate numerically in case of a certain problem
   11. Able to transform a higher order differential equation into a system of first order differential equations
   12. Able to solve ordinary differential equations in case of initial or boundary value problem, even in single and bivariate case

C. Attitudes
   1. Seeks the most efficient algorithm during the solution
   2. Susceptible toward the simple and effective program codes
   3. Attempts to write a well-documented script with comments understandable for others

D. Autonomy and responsibility
   1. Independently performs the solution of the problem assigned as homework

2. Openly receives the well-founded critical comments, accepts the proposals and integrates them during the further work
3. Independently checks in the documentation how to use the commands required to solve the tasks
4. Checks whether there is already a solution for similar problems, and able to apply it with minor conversions to solve the specific task

*2.3 Methods*

Lectures and computer laboratory practices.

*2.4 Course outline*

Main topics of the lectures and labour practices (different number of lessons on even and uneven educational weeks, 1x2 and 2x2)

| week: | Topics of lectures and/or exercise classes |
|---|---|
| 1. | Introduction to a mathematical environment |
| 2. | Loading and saving measurement data, conditionals and loops |
| 3. | Computational errors |
| 4. | Systems of linear equations |
| 5. | Systems of non-linear equations |
| 6. | Regression |
| 7. | Interpolation |
| 8. | Summary - overview |
| 9. | Optimization |
| 10. | Numerical derivation, integration |
| 11. | Ordinary differential equation I. (initial value problem) |
| 12. | Ordinary differential equation II. (boundary value problem) |
| 13. | Summary - overview, Building Information Modelling (BIM) I. |
| 14. | BIM II. |

The above program is tentative and subject to changes due to calendar variations and other reasons specific to the actual semester. The exact schedule is available on the subject's website under the "Detailed course schedule" topic.

*2.5 Study materials*

a) Online materials
   1. Matlab documentation - **https://www.mathworks.com/help/matlab/**
   2. Todd Young and Martin J. Mohlenkamp: Introduction to Numerical Methods and Matlab Programming for Engineers, Department of Mathematics, Ohio University, May 4, 2017, (Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License), http://www.math.ohiou.edu/courses/math3600/book.pdf

b) Presentations, descriptions, tasks available on the educational framework

*2.6 Other information*

1) The use of own laptops during labour practices is allowed if the used softwares are previously installed.

*2.7 Consultation*

Appointments: As specified on the department's website, or in consultation with the course instructors via e-mail

# II. SUBJECT REQUIREMENTS

## 3. ASSESSEMENT AND EVALUATION OF THE LEARNING OUTCOMES

### *3.1 General rules*

The assessment of the learning outcomes specified in clause 2.2 above and the evaluation of student performance occurs via two midterm tests, homework assignments and the activity on labour practices.

### *3.2 Assessment methods*

| **Evaluation form** | abbrev. | **evaluated learning outcomes** |
|---|---|---|
| Homework (Minor homework, summary evaluation) | HW1 | A.4-A.8; B.1-B.7;C.1-C.3;D.1-D.4 |
| 1. Midterm test | MT1 | A.1-A.6; B.1 – B.6; B.8; C.1-C.3 |
| 2. Midterm test | MT2 | A.7-A.11; B.1 – B.12; C.1-C.3 |
| Activity | A | A.3-A.11; B.1-12; C.1-C.3 |

Date of midterm tests and deadlines of assignments/homework can be found in the „Detailed course schedule" on the subject's website.

### *3.3 Evaluation system*

| **abbrev.** | **score** |
|---|---|
| HW | 15% |
| MT1 | 35% |
| MT2 | 35% |
| A | 15% |
| **Sum in the midterm:** | **100%** |

For the homework 0-15 %, for each midterm tests 0-35 % and for the activity 0-15 % of the total sum is available. To successfully complete the subject it is compulsory to acquire at least 40 % of the points in case of the midterm tests individually and 50 % of the total points.

### *3.4 Requirement and validity of signature*

Signature could not be obtained from the subject.

### *3.5 Grading system*

The final grade is determined according to the weighted total points (P) described in section 3.3:

| **grade** | **points (P)** |
|---|---|
| Excellent (5) | 80<=P |
| Good (4) | 70<=P<80% |
| Satisfactory (3) | 60<=P<73% |
| Passed (2) | 50<=P<60% |
| Failed (1) | P<50% |

### *3.6 Retake and repeat*

1) The retake of the midterm tests takes place on the completion week.
2) Homework could be submitted belated (upon payment of the fee specified in the rules) till two weeks after the original deadline.

### *3.7 Estimated workload*

| **Activity** | **hours/semester** |
|---|---|
| contact hours | 14×3=42 |
| preparation for the courses | 14×1=14 |
| preparation for the tests | 2×24=48 |
| homework | 16 |
| **in total** | **120** |

### *3.8 Effective date*

September 1, 2017.