1. Subject name	**Numerical optimization**				
2. Subject name in Hungarian	Numerikus optimalizálás				
3. Code	**BMEKOVRM334**	4. Evaluation type	**exam grade**	5. Credits	**5**
6. Weekly contact hours	**3 (16) Lecture**	**0 (0) Practice**	**1 (5) Lab**		
7. Curriculum	**Logistics Engineering MSc (L)**	8. Role	**Mandatory (mc) at Logistics Engineering MSc (L)**		
9. Working hours for fulfilling the requirements of the subject					**150**
Contact hours	56	Preparation for seminars	13	Homework	28
Reading written materials	38	Midterm preparation	0	Exam preparation	15
10. Department	**Department of Aeronautics and Naval Architectures**				
11. Responsible lecturer	Dr. Rohács József				
12. Lecturers	Dr. Bicsák György				
13. Prerequisites					

14. Description of lectures

Introduction: scope of lectures, content and requirements. System analysis, model generation, modelling and simulation. General models, simplifications. Source of errors, model types and solution possibilities. Analytic, geometric and numerical solutions.
Functions, vectors, matrices, basic operations. Classical and floating-point error-calculation. Sensitivity and numerical stability. Investigation of solution technics. Representing the solutions, evaluation.
Solution of system of equations. Single variable, non-linear equations. Successive approximation, Newton iteration and secant method. Solution of polynomial equation. Horner method and Newton-method.
Numerical solution of linear system of equations. Gauss-elimination and LU decomposition. Numerical solution of Eigenvalue problem.
Extremum problems, optimization. Linear programming, transforming to standard form. Simplex method, dual simplex method. Optimization of non-linear functions. Non-linear programming. Sensitivity analysis, multipurpose linear programming. Goal and object dependent optimisation. Optimisation by using soft-computing techniques. Gradient method.
Examining specific cases, optimization tasks in logistics systems and processes. Fundamentals of game theory.
Functions, series of functions, approximation. Taylor series, MacLaurin series, Fourier series.
Polynomial-interpolation, Newton, Lagrange and Hermite interpolation. Application of Splines. Generating curves and surfaces with using Splines. Bezier polynomials, NURBS surfaces. Approximation, Chebyshev and Padé approximation.
Harmonical analysis, fast Fourier transformation (FFT).
Numerical differentiation, integration. Approximation of derivatives using finite difference method. Approximation of derivatives using Lagrange and Newton interpolation formulas. Numerical integration, general quadrature formula. Trapezoidal and Simpson formula. Romberg iteration.
Initial value problems, ordinary differential equations. Explicit formulas: Euler method, 4th order Runge-Kutta method. Implicit formulas, predictor-corrector methods.
Approximation of partial differential equations. Boundary conditions, finite difference method, finite volume method, finite element method.
Stochastic process modelling. System input data generation. Monte-Carlo simulation.

15. Description of practices

16. Description of labortory practices

MATLAB application of the introduced methods.

17. Learning outcomes

A. Knowledge

- knowing the fundamentals of numerical approximation methods used in engineering instead of analytic algorithms. Knowing to find and apply the most suitable numerical method for a certain problem.

B. Skills

- can implement different algorithms to a programming language and to find the best approximation method for a given mathematical problem.

C. Attitudes

- interested, responsive.

D. Autonomy and Responsibility

- can work individually and in teamwork.

18. Requirements, way to determine a grade (obtain a signature)

2 midterm exams from the theoretical part, 50 points / exam.
1 project work for a group of 4-5 students, for n*100 points (n is the number of students). The points can be divided between the group members according to their wish.
Grade calculation: summing all the points, the total points gives the final grade as follows: 0 – 79 - 1; 80 – 109 - 2; 110 – 139 - 3; 140 – 169 - 4; 170 – 5

19. Opportunity for repeat/retake and delayed completion

Because of the point-collection system, no minimum points are determined for the midterm exams or for the project work. The retake possibilities are the following: on the replacement week the 1st midterm exam, or the 2nd midterm exam can be tried again for 50 points, or a combined 1st+2nd midterm exam retake for 100 points.

20. Learning materials

Examples, documents and training materials, given out during lectures, presentations.
György Bicsák, Dávid Sziroczák, Aaron Latty: Numerical Methods
Ramin S. Esfandiari: Numerical methods for engineers and scientists using MATLAB, ISBN 978-1-4665-8570-6
Erwin Kreyszig: Advanced engineering mathematics, 10th edition, ISBN 978-0-470-45836-5

Effective date	10 October 2019	**This Subject Datasheet is valid for**	Inactive courses