Course name : **Mathematics in modeling of engineering systems**		
Type of study: **Mathematics**	Type of study: **Full-time**	Examination: **Assignment**
Course characteristics: **Compulsory**	Level: **First (B.Sc.)**	Year: **Spring Semester**
type of classes: **lectures, laboratory**	Hours per week: **2 L, 2 Lab**	ECTS points: **6 ECTS**

COURSE GUIDE

COURSE OBJECTIVE

C1. Making the students familiar with the elements of the theory and major algorithms of operations research.

C2. Acquaint students with practical skills to formulate, solve and interpret solutions to problems in the field of operations research, in particular the linear and nonlinear programming.

C3. Introducing the students into using the computer implementation of the presented algorithms and the use of the presented optimization packages.

PREREQUISITES/ ASSUMED BACKGROUND

1. Course of elementary algebra, in particular matrix calculus.
2. Course of the calculus of one and several variables (course of the mathematical analysis).
3. Ability to use different sources of information.
4. Ability to work independently and in a group.
5. Ability to correctly interpret and present their own activities.

LEARNING OUTCOMES and **COMPETENCES TO BE ATTAINED**

LO1 – student is familiar with the basic theory of operation research

LO2 – student is able to independently formulate and solve operations research problems, is able to give them the proper practical interpretation,

LO3 – student is familiar with presented optimization packages and is able to use it in solving the optimizations problems.

COURSE CONTENT

Lectures - Topics	**Hours**
L1 - Course introduction. Matrices and matrix operations.	**2**
L2 - System of linear equations.	**2**
L3 - Introduction to the field of operations research. Basic concepts and notation. Examples of practical optimization problems. Formulating problem and constructing a mathematical model.	**2**
L4 - The linear programming model. Solving linear programming problems: the Simplex method.	**2**
L5 - Duality theory.	**2**
L6 - Transportation problem.	**2**
L7 - Nonlinear programming problems. Convex sets, convex and nonconvex functions, applications in nonlinear problems.	**2**
L8 - Types of nonlinear programming problems. The necessary and sufficient conditions for optimality.	**2**

L9 - The Kuhn – Tucker thoerem, conditions for constrained optimization.	**2**
L10, L11 - Quadratic programming.	**4**
L12 - Introduction to network analysis. The basic terminology of networks and graphs.	**2**
L13 - The network Simplex method	**2**
L14, L15 - Project planning and control with PERT - CPM.	**4**
Σ	**30**
Tutorials - Topics	Hours
Lab. 1 - Matrix operations.	**2**
Lab. 2 - Application of the Gauss – Jordan method for solving system of linear equations.	**2**
Lab. 3, Lab. 4 - Formulating the mathematical model for linear problems, primal-dual relationship.	**4**
Lab. 5 - Application of the Simplex method.	**2**
Lab. 6 ,Lab. 7 - A streamlined Simplex method for transportation problem..	**4**
Lab. 8 , Lab. 9 - Formulating the mathematical model for nonlinear problems, formulating and testing the conditions for optimality.	**4**
Lab. 10, **Lab. 11** - Formulating the Lagranga'e function, solving the nonlinear programming problem using the optimization packages.	**4**
Lab. 12, **Lab. 13**- A few kind of network problems, methods of solving these problems.	**4**
Lab. 14 - PERT and CPM method.	**2**
Lab. 15 - Test.	**2**
Σ	**30**

TEACHING TOOLS

1. – lectures using multimedia presentations
2. – blackboard and chalk or whiteboards and pens

RECOMMENDED AND ADDITIONAL BIBLIOGRAPHY

Lecture notes.
Hillier F., S., Lieberman G., J., *Introduction to operations research*, McGraw-Hill, Inc. 1990
Forst W., Hoffman D., *Optimization – Theory and Practise*", Springer Science + Business Media, 2010
Polyanin A. D., Manzhirov A. V., „Handbook of Mathematics for Engineers and Scientists", Chapman & Hall/CRC, Taylor & Francis Group, 2007
Adams P., Smith K., Vyborny R., Introduction to Mathematics with maple, World scientific Publishing Co. Ltd., 2004.

TEACHERS

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ADDITIONAL NOTES

Links to course unit teaching materials can be found on the http://iisi.pcz.pl/CIaDM/ website for current students.