

**AGH**AGH UNIVERSITY OF SCIENCE  
AND TECHNOLOGY

Module name: Mathematics

Academic year: 2013/2014 Code: RMS-1-101-s ECTS credits: 18

Faculty of: Mechanical Engineering and Robotics

Field of study: Mechatronics with English as instruction language Specialty: —

Study level: First-cycle studies Form and type of study: Full-time studies

Lecture language: English Profile of education: Academic (A) Semester: 1

Course homepage: —

Responsible teacher: dr Jarnicka Jolanta (jarnicka@wms.mat.agh.edu.pl)

Academic teachers: dr Jarnicka Jolanta (jarnicka@wms.mat.agh.edu.pl)

## Description of learning outcomes for module

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Connections with FLO	Method of learning outcomes verification (form of completion)
Social competence			
M_K001	Students can assess their level of understanding of the problem and its possible solution methods. They understand the need for continuous training	MS1A_K01	Activity during classes, Examination, Test
Skills			
M_U001	The student has ability to use the rules of strict, logical thinking in the analysis of physical and technical processes.	MS1A_U07	Activity during classes, Examination, Test
M_U002	The student is able to use the acquired knowledge of mathematics to describe and analyze the basic physical and technical problems.	MS1A_U07	Examination, Test, Execution of exercises
M_U003	The student can obtain information from literature, databases and other sources, can make the selection, interpretation, and draw conclusions.	MS1A_U01	Activity during classes
M_U004	The student is able to work independently and in a team.	MS1A_U02	Activity during classes
Knowledge			
M_W001	The student knows the basic laws of logic and knows how to use them to draw the correct conclusions.	MS1A_W01	Activity during classes, Examination, Test

M_W002	The student knows the basic concepts and theorems of mathematical analysis in the field of calculus (including differentiation, integration, and differential equations), as well as their applications.	MS1A_W01	Activity during classes, Examination, Test
M_W003	The student knows the basic concepts and theorems of algebra and analytic geometry, as well as elements of applied mathematics	MS1A_W01	Activity during classes, Examination, Test

## FLO matrix in relation to forms of classes

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Form of classes										
		Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Others	Fieldwork classes	Workshops	E-learning
Social competence												
M_K001	Students can assess their level of understanding of the problem and its possible solution methods. They understand the need for continuous training	+	+	-	-	-	-	-	-	-	-	-
Skills												
M_U001	The student has ability to use the rules of strict, logical thinking in the analysis of physical and technical processes.	+	+	-	-	-	-	-	-	-	-	-
M_U002	The student is able to use the acquired knowledge of mathematics to describe and analyze the basic physical and technical problems.	+	+	-	-	-	-	-	-	-	-	-
M_U003	The student can obtain information from literature, databases and other sources, can make the selection, interpretation, and draw conclusions.	+	+	-	-	-	-	-	-	-	-	-
M_U004	The student is able to work independently and in a team.	+	+	-	-	-	-	-	-	-	-	-
Knowledge												
M_W001	The student knows the basic laws of logic and knows how to use them to draw the correct conclusions.	+	+	-	-	-	-	-	-	-	-	-

M_W002	The student knows the basic concepts and theorems of mathematical analysis in the field of calculus (including differentiation, integration, and differential equations), as well as their applications.	+	+	-	-	-	-	-	-	-	-	-
M_W003	The student knows the basic concepts and theorems of algebra and analytic geometry, as well as elements of applied mathematics	+	+	-	-	-	-	-	-	-	-	-

## Module content

### Lectures

#### Analytic geometry (in $R^2$ and $R^3$ )

Vectors, properties of vectors, length of a vector operations on vectors, scalar product, the angle between the vectors, Euclidean norm, vector product and scalar triple product, applications, equation of a line and plane in  $R^3$ , orthogonal projection, distance and angle between lines and planes.

#### Differential equations

Differential equations: first order ordinary differential eq., separable and linear equations (variation of parameters, predictor-corrector method), initial-value problems, second order linear equations with constant parameters.

#### Series

Infinite series as a limit of partial sums, necessary condition for the convergence of the series, geometric series, the sum of a series, tests for the convergence of a series (comparison test, ratio and root tests, asymptotic and limit asymptotic test, and " $2^k$ " test), alternating series test, conditional and absolute convergence of a series, power series, the radius of convergence.

#### Limits of functions and continuity

Limit of a function at a point and its properties, one-sided limits, improper limits, asymptotes, continuity of a function at a point – definition and properties, continuous functions and their properties, continuity of elementary functions, intermediate value theorem, extreme value theorem.

#### Derivatives and their applications

Derivative at a point – definition, geometric interpretation, differentiability, basic formulas and techniques of differentiation (sum/difference rule, product rule, quotient rule, chain rule, logarithmic differentiation), mean-value theorems and their consequences, l'Hospital's rule, monotonicity, minima and maxima, first derivative test, higher order derivatives, second derivatives test, global extreme values, closed interval method, concavity, investigation of functions, Taylor's formula with remainder, Taylor expansions of real functions, Taylor series, Maclaurin series.

#### Elements of combinatorics and probability

Combinations, variations, permutations, set of elementary events, the probability-calculation methods, properties, the law of total probability, Bayes' theorem,

probability as a measure, random variable, continuous and discrete random variables, distributions of random variables, central limit theorem.

#### Integrals and their applications

Indefinite integrals: first fundamental theorem of calculus, antiderivative, basic formulas and techniques of integration, substitution rule, integration by parts, integration of rational functions-decomposition into partial fractions, integration of irrational, trigonometric functions.

Definite integral: definition, the net change theorem, substitution rule for a definite integral, applications, including polar co-ordinates and parametric equations, improper integrals, integral test for the convergence of a series.

#### Functions of two or more variables

Function of two variables-definition and properties, quadratic form, limits and continuity, partial derivatives and differentiability, total differential, chain rules, tangent planes, directional derivatives and gradients, maxima and minima of functions of two variables, Lagrange multipliers, implicit functions, double integrals-definition, properties, and applications, line integrals, Green's theorem.

#### Elements of logic and number sets

Basic logical connectives and quantifiers, important logical laws, sets, operations on sets, natural numbers, integers, rational numbers, real numbers, intervals, finite, infinite, bounded, and unbounded sets, principle of mathematical induction, binomial theorem.

#### Functions

Definition, graphs, properties of functions, inverse function, composite function, review of elementary functions and their properties: constant functions, power and root functions, polynomials, rational functions, exponential and logarithmic functions, trigonometric and inverse trigonometric functions, absolute value.

#### Complex numbers

Representation of a complex number: algebraic, polar, and exponential form, algebraic operations, conjugate, module, and argument of a complex number, the fundamental theorem of algebra, equations in the set of complex numbers, de Moivre's theorem, nth root of a complex number.

#### Matrices & systems of linear equations

Definition of a matrix, operations on matrices, matrix equations, determinant of a matrix (definition, properties, and methods of calculation), inverse matrix, rank of a matrix, eigenvalues and eigenvectors, systems of linear equations, Cramer's rule, Gaussian elimination, Kronecker-Capelli theorem.

#### Sequences

Bounded sequence, monotone, arithmetic, and geometric sequence, limit of a sequence and its properties (arithmetic operations on limits, squeeze theorem, etc.), finite limits, improper limits, indeterminate forms, methods of finding limits of sequences, Euler's number as a limit, Cauchy's condition, subsequences.

#### **Auditorium classes**

Program of the classes coincides with the program of the lectures.

#### **Method of calculating the final grade**

The final grade is the arithmetic mean of the grades obtained from classes and exams, rounded up. Positive final grade is awarded only when positive results of exams were obtained.

### **Prerequisites and additional requirements**

Prerequisites and additional requirements not specified

### **Recommended literature and teaching resources**

J. Stewart, Calculus, Early Transcendentals, 6e, Thomson Brooks/Cole, 2008  
 T. Jurlewicz, Z. Skoczylas, Algebra liniowa 1, Oficyna Wydawnicza GiS, Wrocław, 2002  
 W. Krysicki, L. Włodarski, Analiza matematyczna w zadaniach, cz. I i II, PWN, 1993  
 A. Howard, Calculus with analytic geometry, 3rd ed., John Wiley & Sons, 1989

### **Scientific publications of module course instructors related to the topic of the module**

Additional scientific publications not specified

### **Additional information**

None

### **Student workload (ECTS credits balance)**

Student activity form	Student workload
Participation in lectures	90 h
Participation in auditorium classes	90 h
Realization of independently performed tasks	180 h
Preparation for classes	90 h
Examination or Final test	3 h
Summary student workload	453 h
Module ECTS credits	18 ECTS