MODULE DESCRIPTION

Module code	full-time studies:	**Z-ZIP1-E-202**
	part-time studies:	**Z-ZIPN1-E-202**
Module name	**Calculus II**	
Module name in Polish	**Analiza matematyczna II**	
Valid from academic year	**2019/2020**	

MODULE PLACEMENT IN THE SYLLABUS

Field of study	**MANAGEMENT AND PRODUCTION ENGINEERING**
Level of education	**1st degree**
Studies profile	**General**
Form and method of conducting classes	**Full-time and Part-time**
Specialisation	**All**
Unit conducting the module	**Department of Mathematics and Physics**
Module co-ordinator	**Leszek Hożejowski, PhD**
Approved by:	**Dariusz Bojczuk, PhD, DSc**

MODULE OVERVIEW

Type of subject / group of subjects	**Basic**
Module status	**Compulsory**
Language of conducting classes	**English**
Module placement in the syllabus - semester	**Semester II**
Initial requirements	**Calculus I**
Examination (YES/NO)	**YES**
Number of ECTS credit points	**5**

Method of conducting classes		**Lecture**	**Classes**	**Laboratory**	**Project**	**Other**
Per semester	full-time studies:	**30**	**30**			
	part-time studies:	**18**	**18**			

TEACHING RESULTS AND THE METHODS OF ASSESSING TEACHING RESULTS

Category	Symbol	Learning outcomes	Assignations to the directional learning outcomes
Knowledge	W01	A student knows antiderivative and single variable integration.	ZIP1_W01
	W02	A student knows differential calculus of two variables and its application to finding extrema.	ZIP1_W01
	W03	A student knows integration of functions of two variables.	ZIP1_W01
Skills	U01	A student can use basic techniques of integration (integration by substitution and by parts) and compute definite and indefinite integrals of rational, irrational and trigonometric functions.	ZIP1_U14
	U02	A student can differentiate functions of two variables and find relative and constrained extrema.	ZIP1_U14
	U03	A student can evaluate double integrals and apply them in engineering problems.	ZIP1_U17
Social competences	K01	He understands the need for continuous training and improving his competences in the field of mathematical methods used to solve typical engineering problems.	ZIP1_K01
	K02	Is aware of the responsibility for their own work.	ZIP1_K04

TEACHING CONTENTS

Method of conducting classes	Teaching contents
Lecture	Functions of two variables. Domain, contour plan. Partial derivatives of functions of two variables. Generalization for the case of functions of n variables. The total difference and its application to error estimation. Higher order partial derivatives. Local extremum of functions of two variables. Least squares method - obtaining empirical formulas. Weierstrass theorem. Global extremes. Implicit function and its differentiation. The extreme of an implicit function. Conditional extreme of functions of two variables - the method of the indefinite Lagrange multiplier. Application examples. Definition and properties of a double integral. Double integral in the normal range. Change of the order of integration in a double integral. Double integral in polar coordinates. Geometric applications of a double integral (area area, solid volume). The mean value of the function. Applications of the double integral in mechanics. Triple integral in a cuboid. Geometric and physical interpretation. Calculation by conversion to iterated integral.

Classes	Determining and drawing the domain of functions of two variables. Preparation of a contour plan. Calculation of first-order partial derivatives of functions of two and three variables. Estimating the calculation error (absolute or percentage) using the total differential. Calculation of partial derivatives of the second order. Finding the local extremum of functions of two variables. Obtaining empirical formulas by the method of least squares with linear or quadratic dependence of two quantities. Finding the greatest / smallest value of a given function on a closed and limited set. Differentiation of implicit functions. An example of economic application - Calculation of the marginal rate of substitution. Determining the conditional extremum. Tasks (problems) leading to the search for the conditional extreme. Calculation of a double integral in the normal region by conversion to iterated integral (using different order of integration). Calculating the double integral in polar coordinates. Calculating the mean value of a function of two variables. Calculation of the column volume bounded by given areas. 12. Calculating physical quantities using a double integral (eg mass of a plane figure, coordinates of the center of gravity, etc.).

METODS OF ASSESSING TEACHING RESULTS

Symbol	Methods of checking the learning outcomes *(select X)*					
	Oral exam	Written exam	Test	Project	Statement	Other
W01		X	X			
W02		X	X			
W03		X	X			
U01		X	X			
U02		X	X			
U03		X	X			
K01						X
K02						X

FORM AND CONDITIONS OF PASSING

Form of classes	Form of credit	Passing conditions
Lecture	Exam	Obtaining at least 50% of the points.
Classes	Credit with grade	Obtaining at least 50% of the total points of the test (test weights: 0.6 and 0.4, respectively).

STUDENT WORKLOAD

<table>
<tr><th colspan="13">Balance of ECTS points</th></tr>
<tr><th rowspan="3">No.</th><th rowspan="3">Type of student's activity</th><th colspan="10">Student's workload</th><th rowspan="3">Unit</th></tr>
<tr><th colspan="5">full-time</th><th colspan="5">part-time</th></tr>
<tr><td rowspan="2">1.</td><td rowspan="2">Participation in the activities</td><td>Lc</td><td>C</td><td>Lb</td><td>P</td><td>O</td><td>Lc</td><td>C</td><td>Lb</td><td>P</td><td>O</td><td rowspan="2">h</td></tr>
<tr><td>30</td><td>30</td><td></td><td></td><td></td><td>18</td><td>18</td><td></td><td></td><td></td></tr>
<tr><td>2.</td><td>Other (consultation, exam)</td><td>4</td><td>2</td><td></td><td></td><td></td><td>4</td><td>2</td><td></td><td></td><td></td><td>h</td></tr>
<tr><td>3.</td><td>Number of hours of a student's assisted work</td><td colspan="5">66</td><td colspan="5">42</td><td>h</td></tr>
<tr><td>4.</td><td>Number of ECTS credit points which are allocated for assisted work</td><td colspan="5">2,6</td><td colspan="5">1,7</td><td>ECTS</td></tr>
<tr><td>5.</td><td>Number of hours of a student's unassisted work</td><td colspan="5">59</td><td colspan="5">83</td><td>h</td></tr>
<tr><td>6.</td><td>Number of ECTS credit points which a student receives for unassisted work</td><td colspan="5">2,4</td><td colspan="5">3,3</td><td>ECTS</td></tr>
<tr><td>7.</td><td>Work input connected with practical classes</td><td colspan="5">63</td><td colspan="5">63</td><td>h</td></tr>
<tr><td>8.</td><td>Number of ECTS credit points which a student receives for practical classes</td><td colspan="5">2,5</td><td colspan="5">2,5</td><td>ECTS</td></tr>
<tr><td>9.</td><td>Total number of hours of a student's work</td><td colspan="5">125</td><td colspan="5">125</td><td>h</td></tr>
<tr><td>10.</td><td>Punkty ECTS za moduł
1 ECTS=25 hours</td><td colspan="10">5</td><td>ECTS</td></tr>
</table>

LITERATURE

1. Hughes-Hallett D. (2008), *Calculus: Single and Multivariable*, Wiley.
2. Stewart J. (2016), *Calculus,* Cengage Learning.
3. Stewart J., Clegg D.K., Watson S. (2020), *Multivariable Calculus,* Brooks/Cole Cengage Learning.