Co-funded by the Erasmus+ Programme of the European Union

TOPIC PLAN		
Partner organization	Faculty of Sciences, University of Novi Sad, Serbia	
Topic	Complex Numbers and Complex Functions	
Lesson title	Complex Functions and SageMath	
Learning objectives	• Students will understand the historical background that leads to the introduction of complex numbers • Students will understand the connection between complex arithmetic and transformations in plane • Students will understand how to visualize complex numbers using SageMath • Students are encouraged to use technology and different software in their work, while considering problem-based situations	**Methodology** ☐Modeling ☒Collaborative learning ☐Project based learning ☒Problem based learning **Strategies/Activities** ☐Graphic Organizer ☒Think/Pair/Share ☒Discussion questions
Aim of the lecture / Description of the practical problem	The aim of the lecture is to make students able to use SageMath to visualize complex functions and transformations of the plane. As a practical problem the lecturer poses several questions that correlate complex addition to translation and multiplication of comex numbers by real numbers to scaling. The teacher will then pose the question of the geometric interpretation of complex multiplication. This will then lead to a more demanding question of understanding general complex functions and lead to techniques of visualization of complex functions in SageMath.	**Assessment for learning** ☒Observations ☒Conversations ☐Work sample ☐Conference ☐Check list ☐Diagnostics **Assessment as**

Previous knowledge assumed:	• Arithmetic with complex numbers • Elements of Python programming • Graphing functions **R** → **R**	**learning** ☒Self-assessment ☐Peer-assessment ☐Presentation ☐Graphic Organizer ☒Homework **Assessment of learning** ☐Test ☒Quiz ☐Presentation ☐Project ☐Published work
Introduction / Theoretical basics	These lecture plans are designed to implement the lectures that are given in detail in the accompanying material “Complex functions” by Dragan Mašulović. As the theoretical basis for the lecture the lecturer is expected to cover the material in Section 1 “The discovery of complex numbers in Renaissance” (pages 1—3) and part of Section 2 “Complex arithmetic and transformations of the plane” (pages 4—7) of the manuscript and to work several examples on the blackboard.	
Action	As the main part of the lecture the lecturer is expected to cover the material in the second part of Section 2 “Complex arithmetic and transformations of the plane” (pages 7—9) and Section 6 “Graphing complex functions” (pages 10—14) of the manuscript and to work several examples using SageMath.	
Materials / equipment / digital tools / software	The accompanying lecture notes are given the references at the end of this topic plan; Equipment: classroom, green board, chalk in different colors; Digital tools: laptop, projector; Software: SageMath	

Consolidation	The students through the above examples should understand the how complex arithmetic correlates to complex functions and should understand the problems one encounters when graphing arbitrary complex functions.

Reflections and next steps	
Activities that worked	**Parts to be revisited**
After the class, the teacher according to his personal perceptions regarding the success of the class fills in this part	Through the success of the homework done by the students, questions and discussion at the beginning of the next class, the teacher comes to the conclusion which parts of this class should be revised

References

1. D. Mašulović. Complex functions. Manuscript prepared under the auspices of this project proposal
2. J. P. D'Angelo. An Introduction to Complex Analysis and Geometry. American Mathematical Society, 2010
3. V. J. Katz. A History of Mathematics: An Introduction. 3rd Ed, Addison-Wesley, 2009
4. A. Speight. Byte-Size Python. John Wiley & Sons, 2020
5. P. Zimmermann et al. Computational Mathematics with SageMath. Volume 160 of Other Titles in Applied Mathematics, SIAM 2018