Course ID: IIIOZI22	Course name: VISUALIZATION IN SCIENCE EDUCATION		
Cycle: THIRD	Year: FIRST	Semester: II	ECTS credits: 10
Course status: ELECTIVE		Total course hours: 60 Lectures: 30 Laboratory: 30	
Teaching participants:	Teachers and associates with expertise in the field to which the subject belongs		
Prerequisite for enrollment:	-		
Course aims:	• Understanding the role of visual memory, perception and spatial ability for meaningful processing of visual data and information • Ability to accept the challenges of visualization in science education and understanding the limitations and shortcomings of molecular visualization • Ability to find, evaluate and apply specific visualization tools in different teaching situations • Using a specific visualization tool to design a research tool in science education research • Ability to conduct action research on the effects of visualization on a better understanding of scientific concepts and processes.		
Thematic course units:	• The role of visual memory, perception and spatial ability of students in the visualization process • Static and dynamic visualization in science education; macroscopic and submicroscopic visualization and their connection with scientific symbolic language, case studies. • Overview of visualization tools - specific visualization tools for chemical and / or biological education (eg ChemSketch; XDraw Chem, EasyChem, Chem Tool, ArgusLab, Molu Cad, Mol Works, eChem, Yasara View, and plug-ins for Moodle: Chime JMol , Chem Lab, Molecular Workbench, Spartam, etc.). • Designing principles for creating effective visualizations in science education. • Visualization projects in science education - literature review. • Evaluate the effectiveness of visualization tools and projects		

	• • Visualization and e-learning / web-based learning, case studies.
Learning outcomes:	Knowledge: Skills: • Design effective visualization in science education Competences: • Analyze the application of visualization tools for science education • Present the results of visualization and e-learning on the web
Teaching methodology:	Oral presentation Discussion Research
Assessment methods and grading system[1]:	(see tables below)
Literature[2]:	Mandatory literature: 1. Hanwell M. D. et al. (2012). Avogadro: An Advanced Semantic Chemical Editor, Visualization and Analysis Platform. *Journal of Cheminformatics*, Vol. 4. 2. Milner-Bolotin M., Nashon S. M. (2012). The Essence of

Grading criteria

	Criteria	Maximal score	Required score
1.	Class attendance	-	-
2.	Class activities	-	-
3.	Midterm	20	11
4.	Seminar	40	22
5.	Final exam	40	22
	Total	100	55

Scores and grading

Score	Grade (B&H)	Grade (ECTS)
< 55	5	F, FX
55–64	6	E
65–74	7	D
75–84	8	C
85–94	9	B
95–100	10	A

[1] The grading structure for each subject is determined by the Council of the organizational unit before the beginning of the academic year in which the subject is taught as per Article 64, paragraph 6 of the Law on Higher Education of Sarajevo Canton

[2] The Senate of the higher education institution, as an institution, or the Council of the organizational unit of the higher education institution, as a public institution, determines by a special decision, which is published on its website before the beginning of the academic year obligatory, mandatory and recommended textbooks and manuals, as well as other recommended literature based on which exams are prepared and taken as per Article 56, paragraph 3 of the Law on Higher Education of the Sarajevo Canton

	Student Visual-Spatial Literacy and Higher Order Thinking Skills in Undergraduate Biology, *Protoplasma* 249, Suppl. 1, pp. S25-S30 *3.* Blonder R., Sakhnini S. (2012). Teaching Two Basic Nanotechnology Concepts in Secondary School by Using a Variety of Teaching Methods, *Chemistry Education Research and Practice*, 13 (4), pp 500-516. 4. Stull A. T., Hegarty M., Dixon B., Stieff M. (2012). Representational Translation With Concrete Models in Organic Chemistry. *Cognition and Instruction*, 30 (4). pp. 404-434. 5. Gilbert J. K. ed. (2005). *Visualization in Science Education - Models and Modeling in Science Education*. Volume 1, Heidelberg: Springer Verlag. 6. Jmol scripting tutorial and documentation. http://jmol.sourceforge.net/ 7. Segenchuk S. (2007): The Role of Visualization in Education. http://web.cs.wpi.edu/~matt/courses/cs563/talks/education/IEindex.html 8. Jones L.L., Jordan K.D., Stillings, N.A. (2005): Molecular Visualization in Chemistry Education: The Role of Multidisciplinary Collaboration. *Chemistry Education Research and Practice.* On-line version http://www.rsc.org/Education/CERP/issues/2005_3/p2_jones.asp