

Program		Type of studies (cycle)	Third cycle		
		Name of the program		SEE Doctoral Studies in Mathematical Sciences	
<b>Course</b>					
Course title		Chaos			
Course code	Semester	Course status	ECTS credits	Contact hours	
	III		10	30	
Teaching staff	Teacher	Doc. dr. Esmir Pilav			
	Other staff	Prof. dr. Mustafa Kulenović, Prof. dr. Donco Dimovski			
Course goals	The goal of the course is to give to the students a basic knowledge about chaos.				
<b>Course content/topics</b>					
<ul style="list-style-type: none"> <li>• Symbolic dynamics, Smale Horseshoe map. invariant set</li> <li>• Shift map. The structure of the space of symbol sequences.</li> <li>• Conley Moser conditions for chaos.</li> <li>• Liapunov exponents</li> <li>• Sensitivity to initial conditions, topological transitivity.</li> <li>• Density of periodic orbits</li> <li>• Chaos and strange attractors</li> <li>• Linking of periodic orbits. Templates.</li> <li>• Synchronization. Coupling of two dynamical systems.</li> </ul>					
<b>LITERATURE</b>		<b>Grading</b>			
[1] V. I. Arnold, "Ordinary differential equations", various editions. [2] S. Wiggins, Introduction to applied nonlinear dynamical systems and chaos, Springer, 2003. [3] J. Guckenheimer, P. Holmes, Nonlinear Oscillations, Dynamical Systems, and Bifurcations of Vector Fields, Springer, 1983. [4] S. Lynch, Dynamical systems with applications using Mathematica, Birkhäuser, 2007. [5] G. Teschl, Ordinary Differential Equations and Dynamical Systems, Springer, 2009. [6] M. Hirsh, S. Smale, R. Devaney, Differential equations, dynamical systems and an introduction to chaos, Elsevier, 2004. [7] Robert L. Devaney, An Introduction to Chaotic Dynamical Systems, 2nd edition, 2003. [8] Saber N. Elaydi, Discrete Chaos, Chapman-Hall/CRC, 2000. [9] M.R.S. Kulenović, O. Merino, Discrete Dynamical Systems and Difference Equations with Mathematica, Chapman-Hall/CRC, 2002. [10] C. Robinson, Dynamical Systems, CRC, 2nd edition, 1999. [11] K.T. Alligood, T.D. Sauer, J.A. Yorke, Chaos (An Introduction to Dynamical Systems), Springer, 1996.			Criterion	Points	Cut-off points
		1.	Homework assignment	20	10
		2.	Project	30	15
		3	Final exam	50	30
				Total	100