….Introduction to Complex Systems….

- ***COURSE SYLLABUS***

1.	**Course title:**	
	Introduction to Complex Systems	
2.	**Lecturer:**	
	Dr hab. Mariusz Białecki, prof. IGF PAN	
3.	**Field, type and level of studies, year of study:**	
	Mathematical methods for natural sciences, all years of study	
4.	**Course character:**	
	Lecture + exercises	
5.	**Teaching method:**	
	Hybrid (traditional and/or on-line)	
6.	**Language:**	*English, Polish, depending on the audience*
7.	**Course type and number of hours:**	
	Lecture + practical exercises in total 30h (10 x 3h)	
8.	**Estimated load of student's independent work:**	*45h*
9.	**Total workload and number of ECTS points:**	*75h, 3 ECTS*
10.	**Short description and main focus of the course:**	
	I intend to explain and practice understanding mathematical and physical concepts used in modeling complex systems. In the present day, such a "conceptual toolkit" is essential to understanding the vast number of modern applications in all natural sciences. *I will introduce basic notion of nonlinear dynamics (including stability, bifurcations, catastrophes and chaos), spatial models (including cellular automata, kinetic growth phenomena and agent-based spatial models), networks (including small-world phenomenon), simple discrete models of population dynamics (with discussion of pandemics), stochastic systems, power-law distributions, non-Gaussian systems and Self-Organized Criticality. The final choice of scope will be tailored to the skills and needs of the audience.* *The course is aimed at PhD students who would like to take a modern self-contained course in the conceptual background of Complex Systems that are the basis for applications in the natural sciences, and to understand how they are used for constructing models.*	
11.	**References:**	
	An Introduction to Complex Systems by Paul Fieguth. Springer.	

	Modeling Complex Systems by Nino Boccara. Springer. *Complex and Adaptive Dynamical Systems - A Primer by Claudius Gros. Springer.*	
12.	**Prerequisites:** *basic study level of mathematics required*	
13.	**Educational outcomes:**	**PQF level 8 codes:**
	Knowledge: *Student knows and understands:* *- basic concepts of Complex Systems theory* *- mathematical notion used for description of complex dynamics* *- methods of identification and analysis of complex behaviour in diversified natural phenomena* *- exemplary qualitative models exhibiting various types of complex evolution*	*P8S_WG*
	Practical Skills: *Student is able to:* *- understand various aspect of complex evolution manifested in natural phenomena* *- take advantage of the knowledge gained on the lecture in order to identify and properly recognize characteristic properties of complex behaviour in nature* *- analyse complex evolution both qualitatively and quantitatively* *- properly conclude on the ability of making predictions and their limitations*	*P8S_UW*
	Social Skills: *Student is ready to:* *- apply the acquired knowledge to develop skills and competences in his/her own scientific activity* *- critically discuss processes occurring in nature and point out their crucial properties* *- discuss and explain limitations in the ability to predict various natural phenomena*	*P8S_KK*
14.	**Evaluation of the educational outcomes:** *oral exam (in a form of discussion)*	
15.	**Criteria to complete the course:** *at least 70% attendance, final grade depends on the evaluation of the exam on the basis of level of understanding of the selected topic presented by a student.*	
16.	**Contact with the lecturer:** *Email: bialecki@igf.edu.pl, Consultation on a basis of previous arrangement - IGF building, room 514.*	