AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Module name:	Dynamical systems

Academic year:	2019/2020	Code:	ZSDA-3-0255-s	ECTS credits:	2

Faculty of:	Szkoła Doktorska AGH

Field of study:	Szkoła Doktorska AGH	Specialty:	—

Study level:	Third-cycle studies	Form and type of study:	Full-time studies

Lecture language:	English	Profile of education:	Academic (A)	Semester:	0

Course homepage:	—

Responsible teacher:	prof. dr hab. Oprocha Piotr (oprocha@agh.edu.pl)

Module summary

The aim of seminar is presentation and discussion on recent advances in the field of discrete dynamical systems, understood in wide sense (topological dynamics, ergodic theory, symbolic dynamics, etc.).

Description of learning outcomes for module

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Connections with FLO	Method of learning outcomes verification (form of completion)
Skills: he can			
M_U001	Student is able to present advanced research topics (theorems, examples, techniques, results of simulations) in front of audience made of specialists in clear and mathematically strict way.	SDA3A_U02	Activity during classes
Knowledge: he knows and understands			
M_W001	Student is able to describe in general terms a few important research directions in modern theory of dynamical systems, that were recently conducted in good academic centers and published in best mathematical journals.	SDA3A_W02, SDA3A_U02	Activity during classes
M_W002	Student is able to understand and present advanced theorems, examples and techniques related to theory of dynamical systems and ergodic theory.	SDA3A_U01	
M_W003	Student is able to distinguish between different levels of research topics (easy, hard; trivial, good, excellent). He/she is aware level research expected for publication in best mathematical journals.	SDA3A_K01	Activity during classes

Number of hours for each form of classes

| Suma | Form of classes | | | | | | | | | | |
	Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
30	0	0	0	0	0	30	0	0	0	0	0

FLO matrix in relation to forms of classes

| MLO code | Student after module completion has the knowledge/ knows how to/is able to | Form of classes | | | | | | | | | | |
		Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
Skills: he can												
M_U001	Student is able to present advanced research topics (theorems, examples, techniques, results of simulations) in front of audience made of specialists in clear and mathematically strict way.	-	-	-	-	-	+	-	-	-	-	-
Knowledge: he knows and understands												
M_W001	Student is able to describe in general terms a few important research directions in modern theory of dynamical systems, that were recently conducted in good academic centers and published in best mathematical journals.	-	-	-	-	-	+	-	-	-	-	-
M_W002	Student is able to understand and present advanced theorems, examples and techniques related to theory of dynamical systems and ergodic theory.	-	-	-	-	-	+	-	-	-	-	-
M_W003	Student is able to distinguish between different levels of research topics (easy, hard; trivial, good, excellent). He/she is aware level research expected for publication in best mathematical journals.	-	-	-	-	-	+	-	-	-	-	-

Student workload (ECTS credits balance)

Student activity form	Student workload
Udział w zajęciach dydaktycznych/praktyka	30 h
Preparation for classes	10 h
Realization of independently performed tasks	15 h
Contact hours	5 h
Summary student workload	60 h
Module ECTS credits	2 ECTS

Additional information

Module content

Seminar classes

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Teaching methods and techniques:
Seminar classes: Presentation or research results. Discussion.

Warunki i sposób zaliczenia poszczególnych form zajęć, w tym zasady zaliczeń poprawkowych, a także warunki dopuszczenia do egzaminu:
Mark based on evaluation of the presentation and the activity in discussions

Zasady udziału w poszczególnych zajęciach, ze wskazaniem, czy obecność studenta na zajęciach jest obowiązkowa:
Seminar classes:
– Attendance is mandatory: Yes
– Participation rules in classes: Presentation and discussion on selected recent research publications in the field of dynamical systems.

Method of calculating the final grade
Mark based on evaluation of the presentation and the activity in discussions

Sposób i tryb wyrównywania zaległości powstałych wskutek nieobecności studenta na zajęciach:
The student should report to the lecturer to determine the individual way of catching up.

Prerequisites and additional requirements
Student has knowledge of mathematical analysis, topology and measure theory at a level of standard undergraduate courses.

Recommended literature and teaching resources
1.R. Devaney, An introduction to chaotic dynamical systems, Second edition, Studies in Nonlinearity, Addison-Wesley Publishing Company, Redwood City, 1989.

2.C. Robinson, Dynamical systems. Stability, symbolic dynamics and chaos, Second edition, CRC Press, Boca Raton, 1999.
3.P. Walters, An introduction to ergodic theory, Springer-Verlag, New York-Berlin, 1982.
4.Kůrka, Petr. Topological and symbolic dynamics. Cours Spécialisés [Specialized Courses], 11. Société Mathématique de France, Paris, 2003.
5.Einsiedler, Manfred; Ward, Thomas. Ergodic theory with a view towards number theory. Graduate Texts in Mathematics, 259. Springer-Verlag London, Ltd., London, 2011.
6.Aoki, N.; Hiraide, K. Topological theory of dynamical systems. Recent advances. North-Holland Mathematical Library, 52. North-Holland Publishing Co., Amsterdam, 1994

Scientific publications of module course instructors related to the topic of the module

P. Oprocha, P. Potorski, P. Raith, "Mixing properties in expanding Lorenz maps", Adv. Math., 343 (2019), 712-755.

J. Boroński, J. Kupka and P. Oprocha, "Mixing completely scrambled system exists", Erg. Th. Dynam. Syst., 39 (2019), 62-73.

P. Oprocha, "Double minimality, entropy and disjointness with all minimal systems", Discrete Contin. Dyn. Syst., 39 (2019), 263—275.

C. Good, P. Oprocha, M. Puljiz, "Shadowing, asymptotic shadowing and s-limit shadowing", Fund. Math., 244 (2019), 287-312.

J. Boroński, A. Clark and P. Oprocha, "A compact minimal space Y such that its square YxY is not minimal", Adv. Math., 335 (2018), 261-275.

W. Brian, P. Oprocha,"Ultrafilters and Ramsey-type shadowing phenomena in topological dynamics", Israel J. Math., 227 (2018), 423-453.

Y. Dong, P. Oprocha and X. Tian, "On the irregular points for systems with the shadowing property", Erg. Th. Dynam. Syst.,28 (2018), 2108-2131.

Additional information
None