

Suggested curriculum in Differential Equations from the Dynamical Systems Perspective

Responsible: Prof. Jerzy Ombach

1st year

title	kind of activity	hours/ week	hours/ year	form of crediting	credits
General School Seminar	seminar	2	60	participation	4
Seminar	seminar	2	60	participation	6
Mathematical Analysis	lectures, classes	4 2	60 30	exam	12
Ordinary Differential Equations	lectures	2	30	exam	5
Partial Differential Equations I	lectures	2	30	exam	5
Theory of General Dynamical Systems; Selected Topics	lectures	2	30	exam	5
Dynamical Systems and Chaos	lectures	2	30	exam	5
Partial Differential Equations II	lectures	2	30	exam	5
Math Software Tool Pack	laboratory	2	30	exam	5
Tutorials	tutorial	2	60	as arranged with tutor	4

2nd year

title	kind of activity	hours/ week	hours / year	form of crediting	credits
General School Seminar	Seminar	2	60	participation	4
Seminar	Seminar	2	60	participation	6
Topological Dynamical Systems	Lectures	2	30	exam	5
Theory of Differential Operators	Lectures	2	30	exam	5
Topological Methods of Differential Equations	Lectures	2	30	exam	5
Oscillation Theory	Lectures	2	30	exam	5
Tutorials	Tutorial	2	60	as arranged with tutor	4
Diploma project	Individual work	10	300	diploma exam	30

Mathematical Analysis. vector spaces and linear maps, metric spaces, continuity and convergence, series, differentiation, chain rule, mean value theorem, implicit and inverse functions theorem (Banach contraction principle), Taylor theorem, measures, integral with respect to a measure.

Responsible: Prof. Roman Szrednicki

Ordinary Differential Equations. Linear ODE in \mathbb{R}^n : Jordan form, exponential matrix. ODE of n-th order. Existence and uniqueness, maximal solutions.

Responsible: Dr. Klaudiusz Wójcik

Partial Differential Equations I and II. Well-posed problems, classical, weak and viscosity solutions. Transport equation. Second -order elliptic equations. Second order parabolic equations. Applications of PDF to stochastic processes. Second order hyperbolic equations. Weak solutions of the boundary value problems for Poissons equations – energy method. Viscosity solutions and application to mathematical finance, Jensens maximum principle.

Responsible: Prof. Bolesław Szafirski

Theory of General Dynamical Systems; Selected Topics. Autonomous differential equations. Dynamical systems and semi-systems ; Local dynamical systems. Trajectories and semi-trajectories, motions, invariant sets, minimal sets. Limit sets, prolongations, prolongational limit sets. Stability

theory; Stability of sets and motions; Lyapunov functions. Periodic, pseudo-periodic and asymptotically periodic motions. Retract theorem of Tadeusz Ważewski.

Responsible: Prof. Andrzej Pelczar

Dynamical Systems and Chaos.

1. Examples: Kepler's laws, evolutionary stable strategies, harmonic oscillator, equations: Van der Pol, Lorentz, Henon-Heiles, maps: rotations, logistic, Henon, cat, baker, standard, horseshoe, systems: Hamiltonian, gradient.

2. Problems: stationary and periodic points, recurrent behaviour, stability, stable and unstable manifolds, attractors, invariant measures, ergodicity, mixing, classification, symbolic dynamics, generic properties, structural stability, bifurcations, catastrophes.

3. Chaos: sensitive dependence on initial conditions, toral automorphisms, homoclinic points, hyperbolic systems, Lyapunov exponents, entropy, strange attractors, fractals.

Responsible: Dr Wojciech Ślomyński

Math Software Tool Pack. Computer room, TEX, LATEX, AMSTEX: basic features and structures, personalizing, including graphics. Maple: algebraic manipulations, graphics, programming, packages.

Responsible: Prof. Jerzy Ombach

Topological Dynamical Systems. Continuous systems vs. discrete systems. Stationary points, periodic points, regular points. Topological properties of sets of these points. Semidynamical systems. Advanced properties of two-dimensional systems. Poincaré-Bendixson Theorem. Stability and removable stability. Persistence in dynamical systems. Ura-Kimura Theorem. Isomorphisms of dynamical systems. Impulsive systems.

Responsible: Dr. Krzysztof Ciesielski

Theory of Differential Operators. Sobolev spaces. Poisson equation. Heat equation. Wave equation. Semigroup theory. Monotonicity methods. Fixed point methods. The calculus of variations.

Responsible: Dr. Joanna Orewczyk

Topological Methods of Differential Equations. Brouwer fixed point theorem, Brouwer degree, fixed point index. Schauder fixed point theorem, Leray-Schauder degree, coincidence degree. Periodic solutions.

Responsible: Prof. Roman Szrednicki

Oscillation Theory. Oscillations of non-linear differential equations in \mathbb{R} (of possibly higher order than one), in particular, Lasota-Ważewska model of blood cells. Linear systems in Banach spaces and criteria for oscillations in particular cases of functional differential equations, partial differential equations and difference equations.

Responsible: Dr Jacek Tabor