

## **Midterm Homework**

**Everybody can choose a topic on a first-came-first-served basis. The list of topics is a selection from Wolfram Demonstrations Project and can be found on the webpage of 'Introduction to Nonlinear Dynamical Systems' ('Nemlineáris dinamikus rendszerek alapjai').**

Each homework consists of a theoretical part and a practical part. The theoretical part should be a nicely illustrated text describing both the origin and the environment of the problem and its solution. A short list of references is also needed. Together with the figures included, the densely typed text should not be shorter than 5 pages. The practical part should be the commented MATLAB version of the respective MATHEMATICA code and, running without errors, it should be able to reconstruct the results presented by Wolfram. With the consent of the lecturer, topics that fall outside the list below can be chosen, too.

Exceptionally good homeworks will score some extra points. The instructors and the lecturer are happy to answer the questions that arise in due course of preparing the homework. All e-mails will be answered soon and appointments can be arranged, too.

The complete MATLAB code, together with the electronic version of the theoretical part, should be sent to one of the instructors by e-mail. A printed copy of the theoretical part should be given to the lecturer. (Please, just drop them into the box near the door to room No.231.)

The **deadline is 11:59 PM on Wednesday, December 7, 2016.**

## **The list of topics:**

**Van der Pol Oscillator**

**The Alpha and Beta Components of the Hodgkin-Huxley Model**

**Hopf Bifurcation in the Sel'kov Model**

**Structural Instability of a Supercritical Pitchfork Bifurcation**

**Motion of a Pendulum in the Wind**

**Bifurcation Diagram for the Three-Variable Autocatalator**

**Group Chase and Escape**

**Sledding on a Bumpy Slope: Chaos and Strange Attractor**

**Biodiversity in Spatial Rock-Paper-Scissors Games**

**Predator-Prey Ecosystem: A Real-Time Agent-Based Simulation**

**Garbage Collection by Ants**

**Ecosystem Dynamics**

**Predator-Prey Dynamics with Type-Two Functional Response**

**Neuronal Bursting**

**Hindmarsh-Rose Neuron Model**

**Neural Impulses: The Action Potential in Action**

**Chaotic Attractor in Tumor Growth**

**Dynamical Network Design for Controlling Virus Spread**

**Contagion in Random and Scale-Free Networks**

**Sensitivity Analysis of Transition Phases of Perturbed Gene Pathways with a Neural Network**

**The Moran Process**

**Pen Falling Off a Finger**

**Simplest Chaotic Circuit**

**Chaotic Oscillation Circuit**

**IFS: Rotation, Translation, and Scaling**

**Spring Pendulum**

**Solving the Cable Equation**

**Two-State Protein Melting Curve (N, P, T Ensemble)**

**Elementary Processes in Protein Folding**

**A Simple Model for Multiple Epidemics**

**Optimal Induction of Foreign Protein Synthesis**

**Spontaneous Oscillations in Yeast Chemostat Cultures**

**A Nonlinear Stage-Structured Cannibalism Model**

**Milk Centrifugation to Cream and Skim**

**Cellular Automata Model of an MPA Fishery**

**Maximizing the Present Value of Resource Rent in a Gordon-Schaefer Model**

**Game of Life in 3D Layers**

**Hacker's Symbol: The Glider in the Game of Life**

**Diauxic Growth of Bacteria on Two Substrates**

**Diffusion-Limited Aggregation: A Real-Time Agent-Based Simulation**

**Activator-Inhibitor Cellular Automata**

**Bioeconomics of a Discrete Ricker Model with Delayed Recruitment**

**Desynchronization Dynamics of Two Coupled Oscillators**

**Attraction and Repulsion in Dynamical Systems**

**Fed-Batch Fermentation**

**Competition for Territory: The Levins Model for Two Species**

**Bifurcation in a Model of Spruce Budworm Populations**

**Cellular Automaton Model of Pine Savanna Dynamics in Response to Fire and Hurricanes**

**Voter Model**

**Torsion pendulum**

**Foucault's pendulum**

**Synchronizing pendulum clocks**

**Romeo and Juliet**

**Chaotic Dynamics of a Modulated Semiconductor Laser**

**Hopf Bifurcation in the Brusselator**

**Pendulum with Three Magnets**

**Chaotic Itinerary but Regular Pattern**

**Study of the Dynamic Behavior of the Rossler System**

**Comparing Leapfrog Methods with Other Numerical Methods for Differential Equations**

**Compass Needle in Uniform and Rotating Magnetic Fields**

**Memristor Based Chaotic System**

**Sensitivity to Initial Conditions in Chaos**

**Phase Space of an Intermittently Driven Oscillator**

**Chaos While Sledding on a Bumpy Slope**

**Michaelis-Menten Enzyme Kinetics and the Steady-State Approximation**

**Ball Bouncing in a Potential Well**

**Mackey-Glass Equation**

**Pursuit Curves**

**Chaotic Itinerary but Regular Pattern**

**Bifurcation Analysis of a Cubic Memristor Model**

**Flying to the Moon**

**Mathematics of Tsunamis (pretty hard)**

**Collatz Problem as a Cellular Automaton**

**Double Pendulum**

**The Rossler Attractor**

**A Triangle Model of Criminality**

**Herd Immunity for Smallpox**

**Reflections in an Elliptical Region**

**Gingerbreadman Trajectories**