



**'How do I put together the exam for this class? -  
my design principles'**

Wulfram Gerstner

# Final week of lectures

## Exam:

- written exam 2nd July 2021 from 16:15-19:00  
exam in parallel in 2 rooms: SG1 and AAC106;  
seating assignment to rooms will be announced
- miniprojects counts 30 percent towards final grade

## For written exam:

- bring 1 page A5, double-sided of own notes/summary
- HANDWRITTEN!

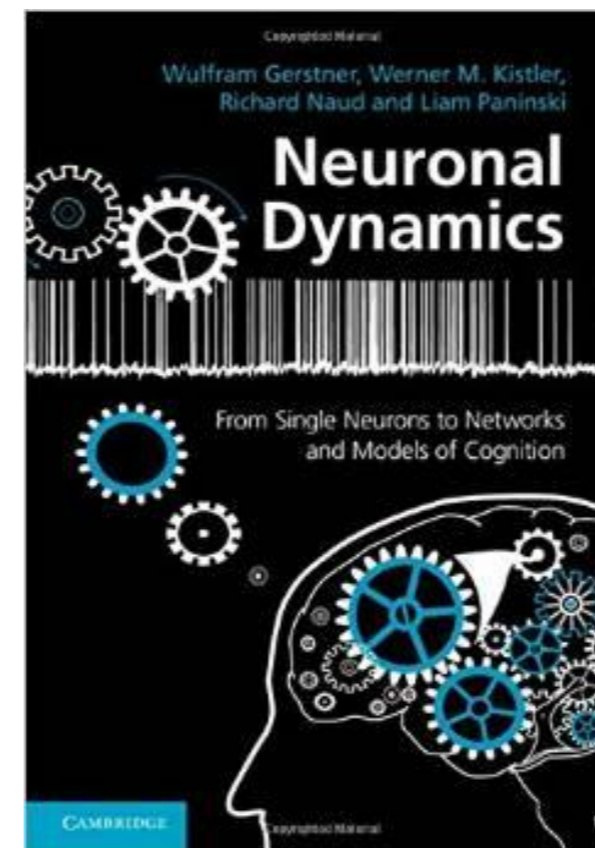
# Biological Modeling of Neural Networks

Written Exam (70%)  
+ miniproject (30%)

Miniproject consists of 2 extended computer exercises, of which you have to hand in 1 (teams of two students)

Textbook:

<http://neurondynamics.epfl.ch/>



Video (two possibilities):

<https://lcnwww.epfl.ch/gerstner/NeuronalDynamics-MOOCall.html>

<https://courseware.epfl.ch/>

# **Biological Modeling of Neural Networks**

Wulfram Gerstner

EPFL, Lausanne, Switzerland

TAs in 2021:

*Valentin Schmutz (head)*

*Sophia Becker*

*Shuqi Wang*

*Christos Sourmpis*

*Martin Barry*

**COURSE WEBPAGE:**

**Moodle.epfl.ch**

**Week 1: A first simple neuron model/  
neurons and mathematics**

**Week 2: Hodgkin-Huxley models and  
biophysical modeling**

**Week 3: Two-dimensional models and  
phase plane analysis**

**Week 4: Two-dimensional models (cont.),  
type I and type II models**

**Week 5,6: Associative Memory,  
Hebb rule, Hopfield**

**Week 7-10: Networks, cognition, learning**

**Week 11,12: Noise models, noisy neurons  
and coding**

**Week 13: Estimating neuron models for  
coding and decoding: GLM**

**Week x: Online video: Dendrites/Biophysics**

## LEARNING OUTCOMES

- Solve linear one-dimensional differential equations
- Analyze two-dimensional models in the phase plane
- Develop a simplified model by separation of time scales
- Analyze connected networks in the mean-field limit
- Formulate stochastic models of biological phenomena
- Formalize biological facts into mathematical models
- Prove stability and convergence
- Apply model concepts in simulations
- Predict outcome of dynamics
- Describe neuronal phenomena

## Transversal skills

- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Collect data.
- Write a scientific or technical report.

Look at samples of past exams

Use a textbook,  
(Use video lectures)  
don't use slides (only)

miniproject

# What do I have in mind when I prepare the exam?

- Phase plane to analyze two-dimensional models
- Separation of time scales to simplify model
- Mean-field approach to analyze connected networks  
(competition, Hopfield, random connectivity)
- Stochastic modeling  
(stochastic diff. eq., time-dep. mean, interval distribution)
- Formalize biological facts into mathematical models  
(interpretation of equations)
- Prove stability and convergence  
(fixed points, stability)
- Predict outcome of dynamics  
(oscillations, fixed points)

- **Exams from previous years are on moodle.**
  - All exam questions are similar to exercises
  - Solution to exam questions is not given  
(you can check your solution by comparing with exercises)
- **Suggested preparation:**
  - redo exercises
  - look at 3 or 4 exams  
(some old exams contain problems on Fokker-Planck eq. ,  
but these are not a topic in this year's exam)
  - prepare your handwritten A5 sheet
- **NOTE: Exam tests other capabilities than miniproject**