



LUND
UNIVERSITY

EITP25 2020

EITP25 – General information

LAST UPDATED 24 March



Course information

Aim

The purpose of this course is to give an in depth understanding for the physics of common memory device technologies with focus on non-volatile memories. Furthermore, the course covers how these memory devices can be integrated to create neuromorphic hardware for applications in machine learning and artificial intelligence. Finally, the course gives an introduction to the architectures and algorithms that are used in machine learning, to give a basic understanding for the needs that memory devices and their connections need to fulfil.

Course responsible

Mattias Borg

Assistant Professor Nanoelectronics

Research

*Nanomaterials integration,
Ferroelectric and RRAM devices,
Neuromorphic devices and systems*

Contact

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E2324 (normally)

046 222 90 99



Syllabus

Lecture modules

F1-F2.

Introduction to memory technologies

F3-F4.

Machine Learning Fundamentals

F5-F7.

Neuromorphic computing

F8-F12.

Emerging memory technologies

F13-F14.

Neuromorphic Hardware in Reality

Lab exercise

1.0 hp.

Measurement
and analysis of
RRAM

Hand-in assignment (elective)

Block 1

Block 2

Block 3

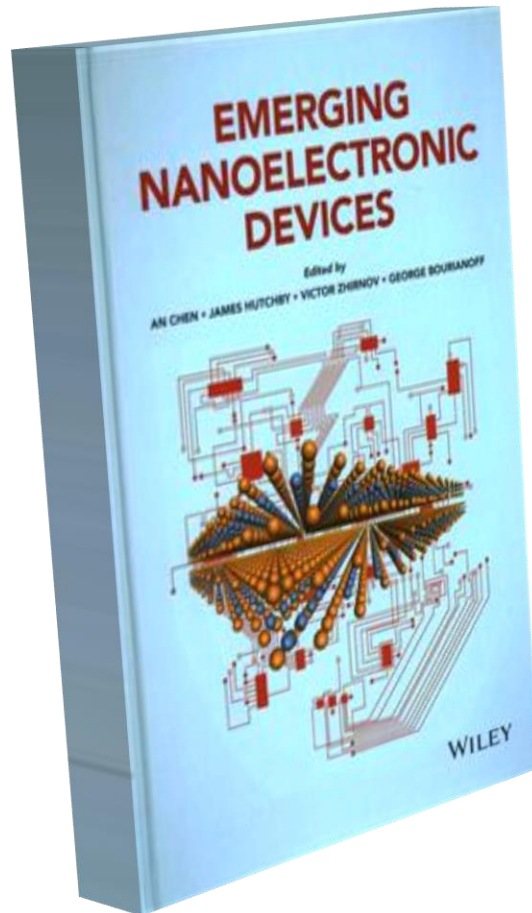
Group Project

2.5 hp. Simulation of Spiking Neural
Net for image classification

Examination

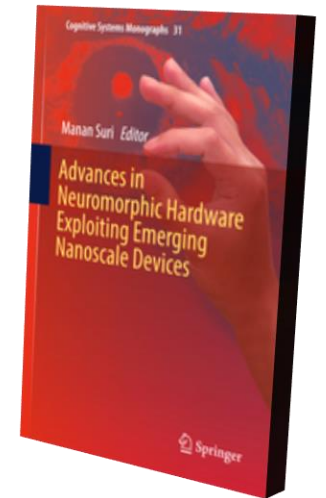
4.0 hp Written exam

Course material



Chen, Hutchby, Zhirnov and Bourianoff

- Many lectures are based on Chen et al.
 - L2, L5, L8, L9, L10, L14
- In addition, many research papers
 - Links (will be) available on Canvas
 - Refer to references on slides
- Additional learning material
 - Blogs, videos



Suri

We use just a bit,
and there are options

Canvas

canvas.education.lu.se



- Account
- Dashboard
- Courses
- Calendar
- Inbox
- Studio
- Help

EITP25 > Modules

2020 VT/Spring

Home

- Announcements
- Assignments
- Discussions
- Grades
- People
- Syllabus
- Quizzes
- Modules
- Conferences
- Collaborations
- Chat
- Office 365
- Google Drive

Information

General information

- Important information about the Lectures
- Course Literature
- EITP25 - General information 19 March.pdf
- Forum - Questions about the Course

Information about hand-ins, lab, project

Assignments

Optional Hand-in assignments

- General Information about Hand-ins
- Hand-in 2 : Examining the STDP learning mechanism
14 Apr | 3 pts

Schedule, and deadlines

View Course Stream

View Course Calendar

To-do

- Lectures will be given online! 17 Mar at 23:30 |
- Prepare for the start of the ... 23 Mar at 16:01 |
- Lecture [TE] 24 Mar at 15:00 |
- Lecture [TE] 26 Mar at 13:00 |
- Lecture [TE] 31 Mar at 13:00 |
- Lecture [TE] 2 Apr at 13:00 |
- Lecture [TE] 3 Apr at 13:00 |

Introduction

Lecture 1 - Introduction

- Learning Materials for L1

Lecture 2 - Current Memory Technologies

Lecture modules (slides, links..)

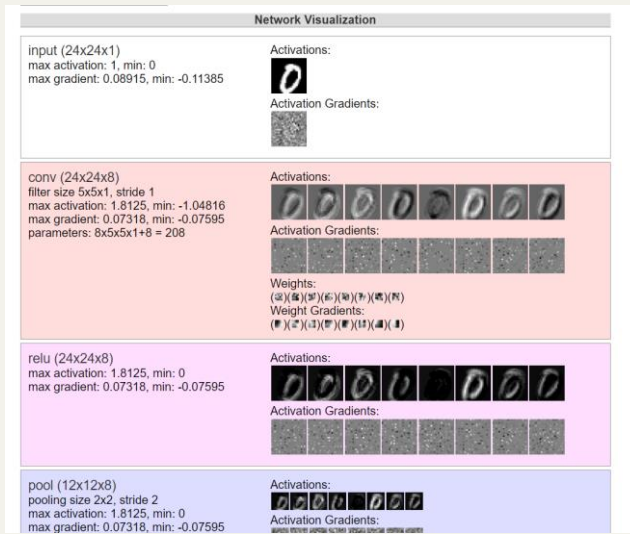
Hand-in assignments

- 3 assignments, each can give 3 points on the exam (max 9)
 - BUT, full points requires excellent work and nice report
- Each assignment is available for 1 week before the deadline

Assignment 1

9 April

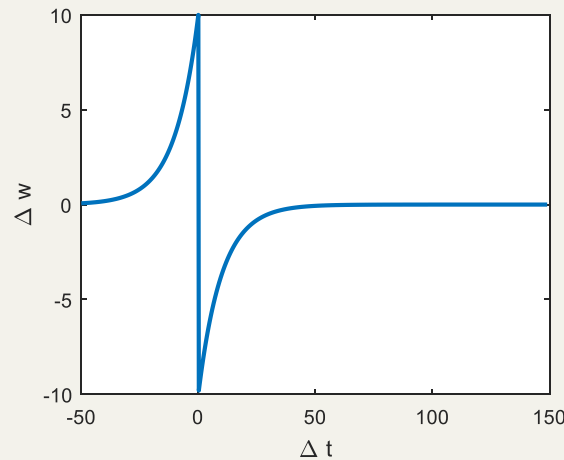
– Play around with CNN



Assignment 2

28 April

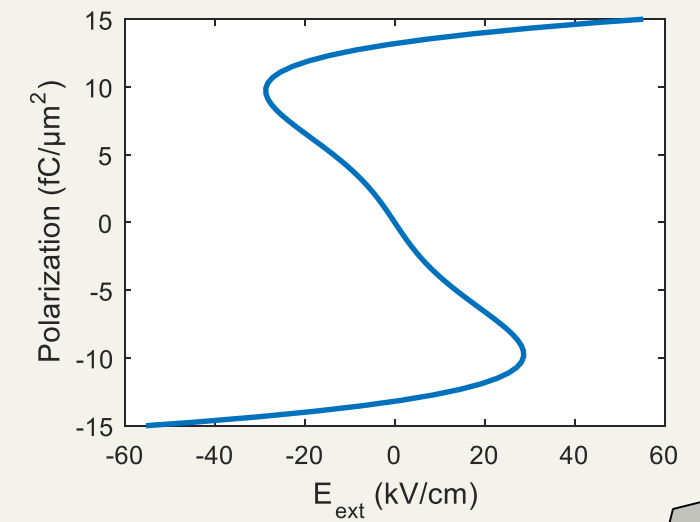
– STDP in SNNs



Assignment 3

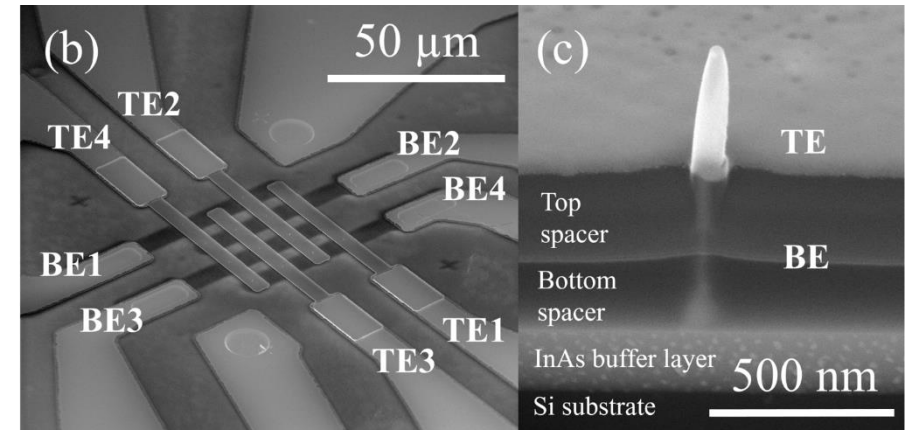
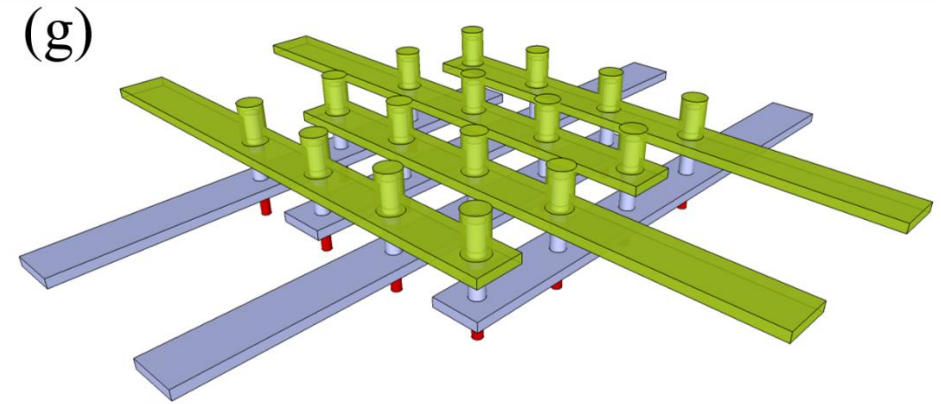
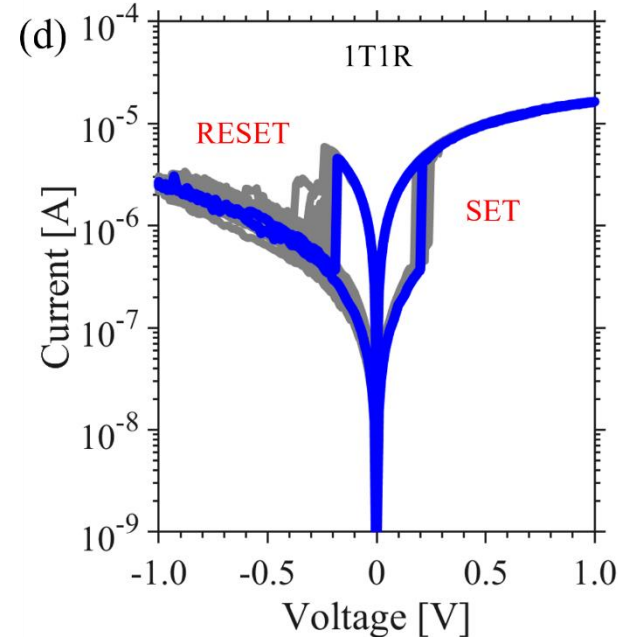
19 May

– Analysing ferroelectric polarization



Lab exercise

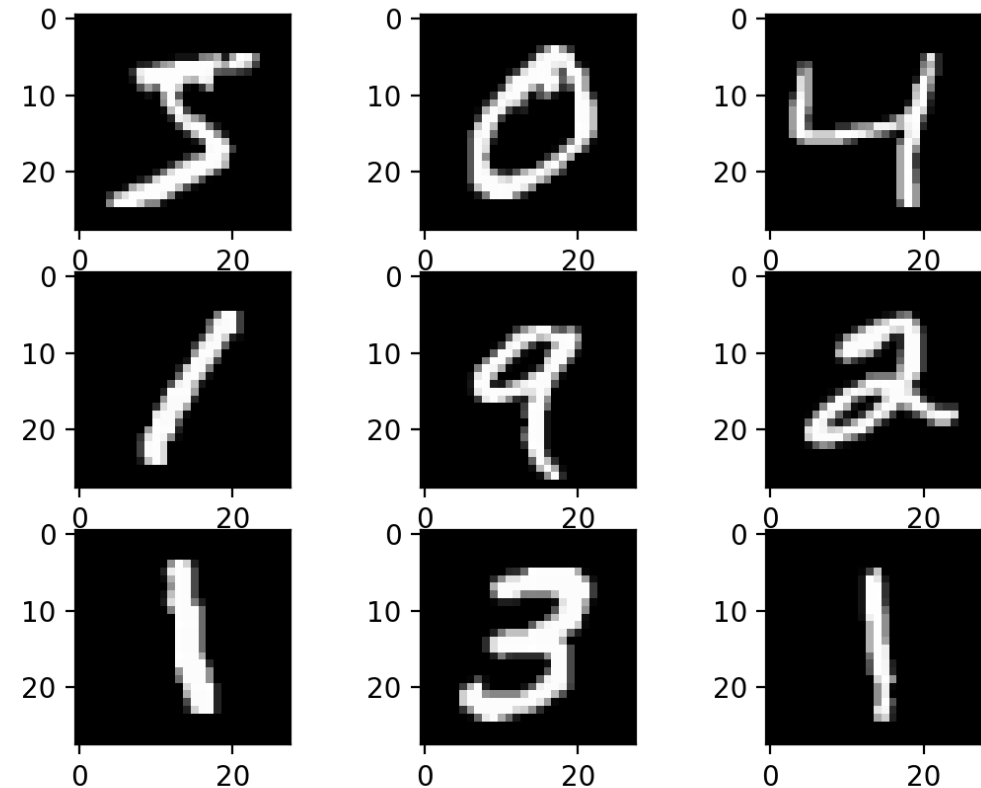
- Electrical characterization of HfO_2/ITO RRAM devices integrated on vertical nanowires
- Analysis of measurement data
- Groups of four students
- When: Scheduled 29 April 8-12
 - ~~Planned: 2h measurement session~~
 - Alternative: Virtual demonstration over Zoom
- Analysis and Lab report:
 - Performed per group
 - Submit report through Canvas



Group Project

- Groups of up to four students
- Task: Build spiking neural network to perform image classification
- Software to use: BRIAN2 python library
 - <https://brian2.readthedocs.io/en/stable/>
- Project will **start 27 April**
 - More details as the time draws near
- Examination:
 - Report and source code
 - **Deadline 31 May**

MNIST data set



Examination

- Exam is planned for 4 June 14-18
- Current plan is for regular examination, this may change...
 - Update: Probably home exam
- “Will this be on the exam?”
 - Anything that we bring up on Lectures/Lab may come...
 - Refer to lecture slides/notes.

