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

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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

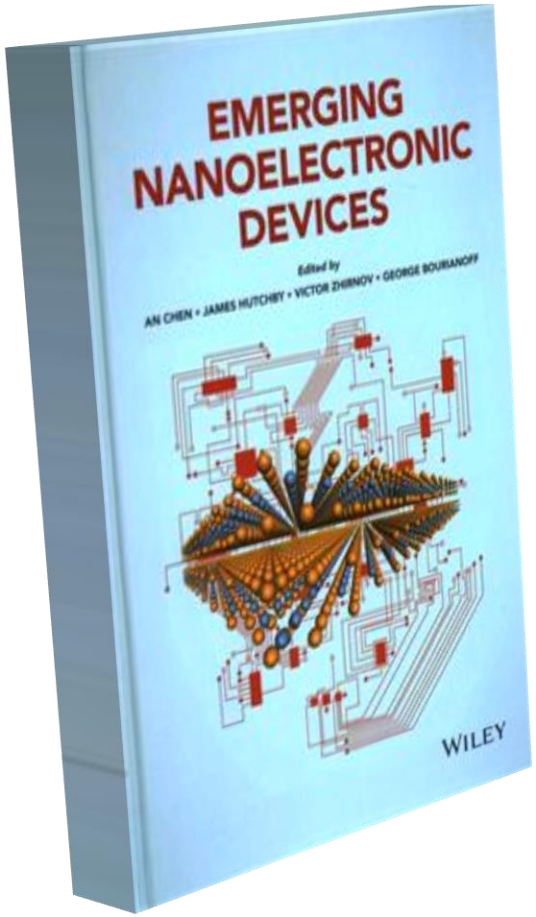
Group Project

- 2.5 hp. Simulation of Spiking Neural Net for image classification

Examination

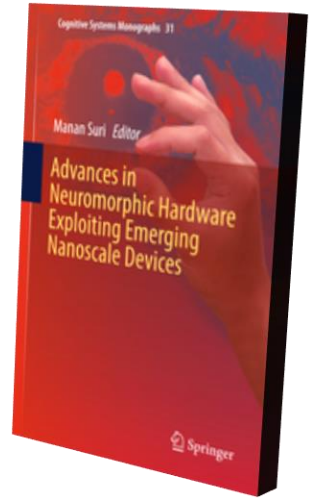
- 4.0 hp Written exam

Course material



Chen, Hutchby, Zhirnov and Bourianoff

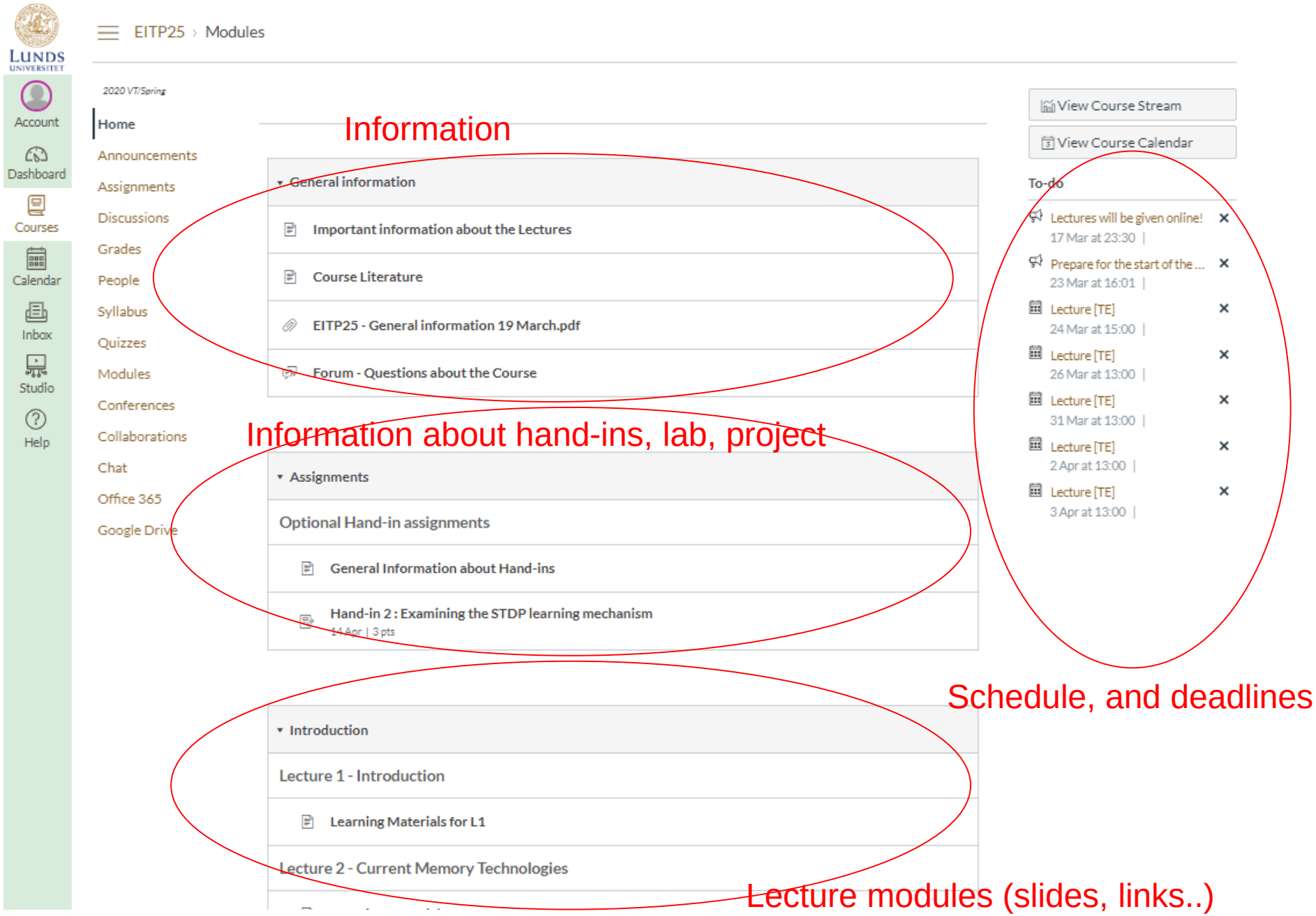
- Many lectures are based on Chen et al.
  - L2, L5, L8, L9, L10, L14
- In addition, many research papers
  - Links (will be) available on Canvas
  - Refer to references on slides
- Additional learning material
  - Blogs, videos



Suri
We use just a bit,
and there are options

Canvas

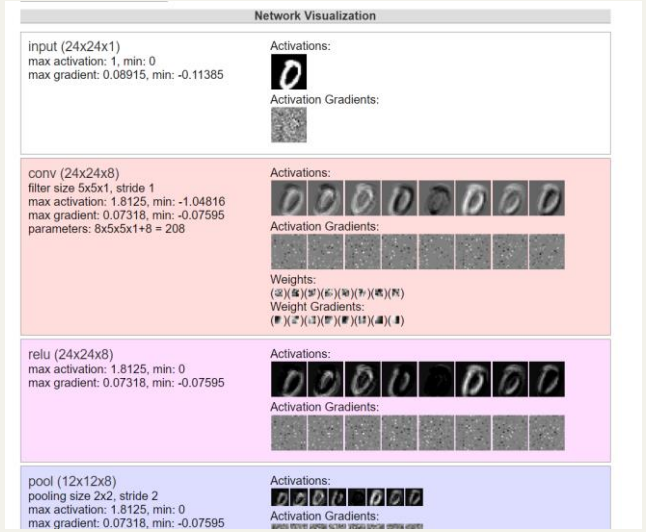
canvas.education.lu.se



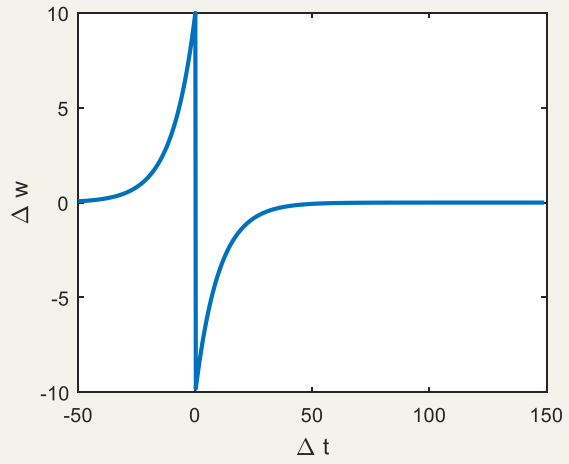
Hand-in assignments

- 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

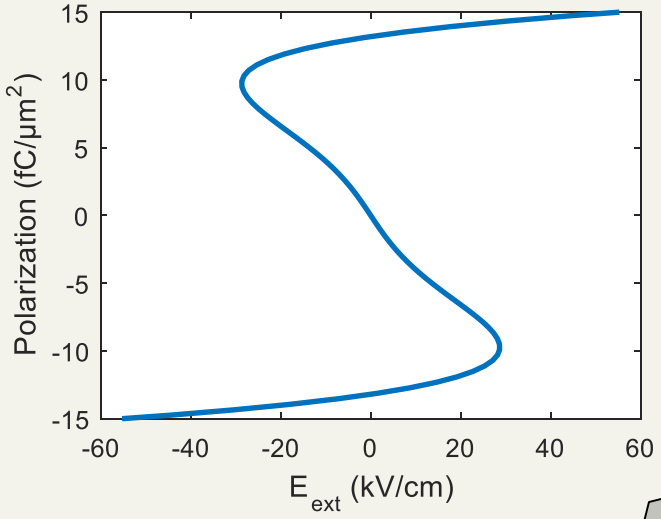
Assignment 1 **9 April**
– Play around with CNN



Assignment 2 **28 April**
– STDP in SNNs



Assignment 3 **19 May**
– Analysing ferroelectric polarization

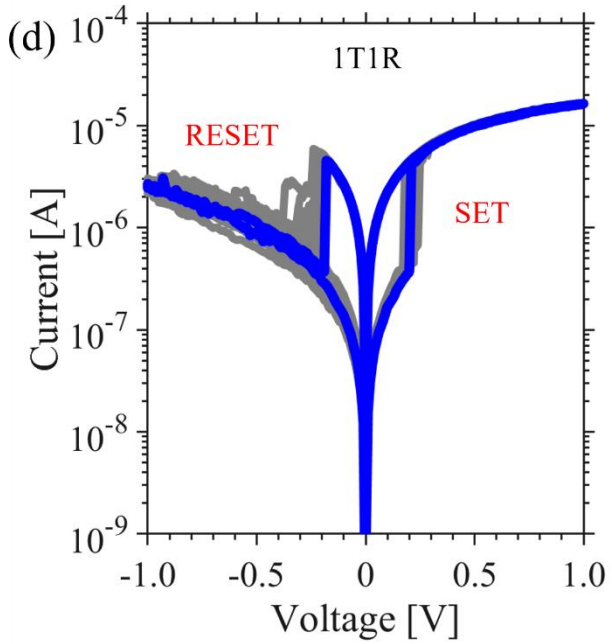


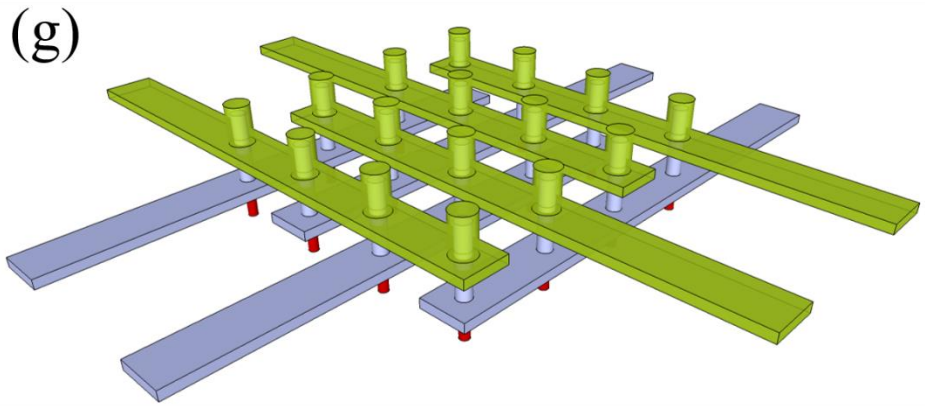
Lab exercise

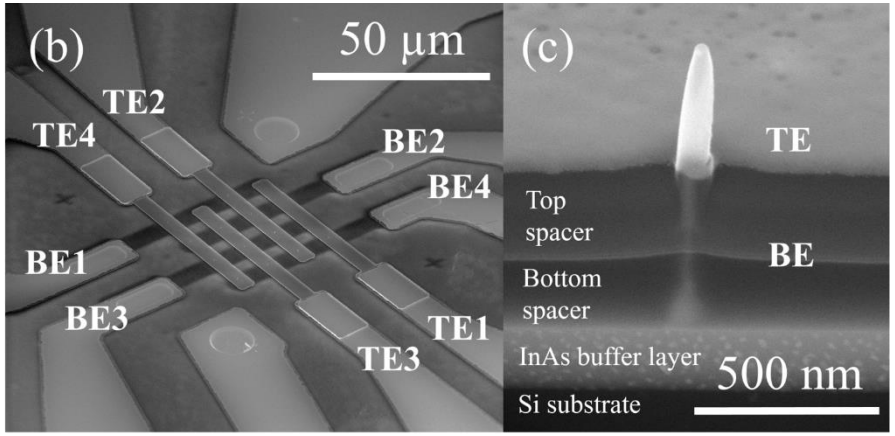
- Electrical characterization of HfO_2/ITO RRAM devices integrated on vertical nanowires
- Analysis of measurement data

- 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

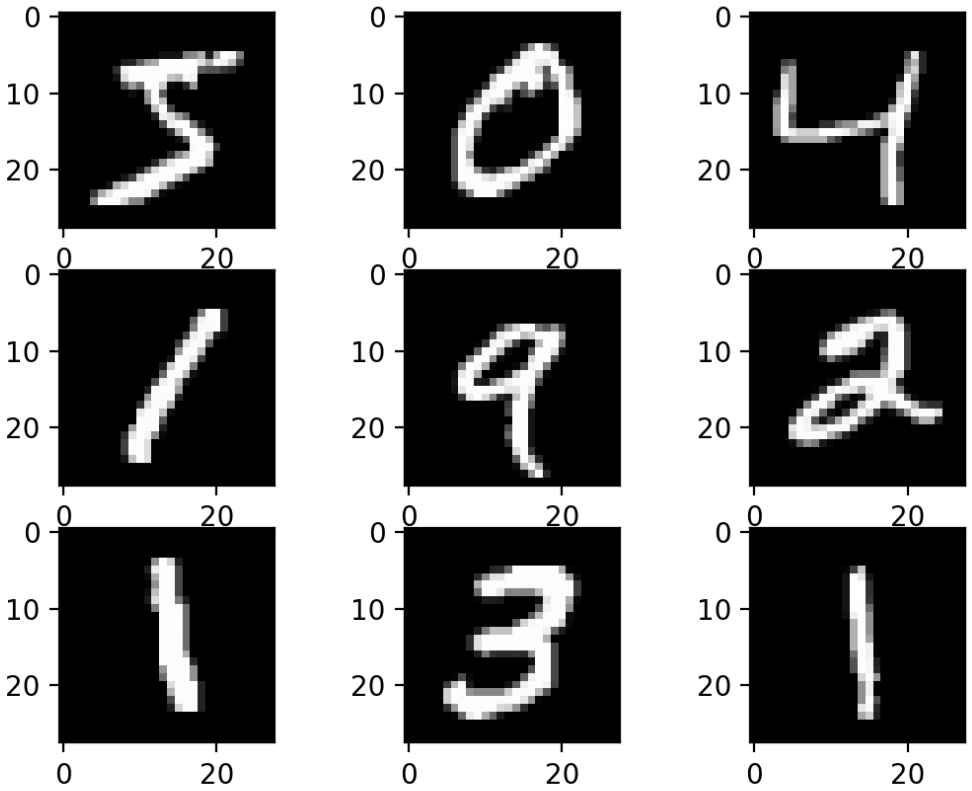
- Groups of up to four students
- Task: Build spiking neural network to perform image classification

- 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.