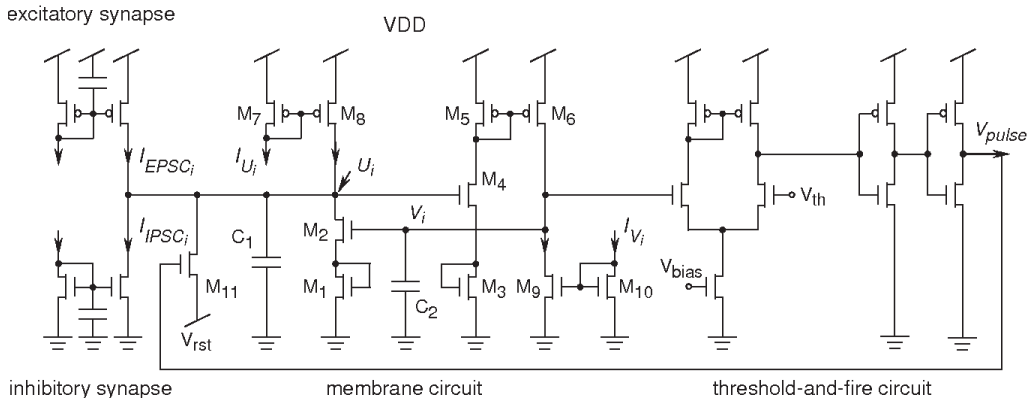
Lehrstuhl für Schaltungsentwurf
Fakultät für Elektrotechnik und Informationstechnik
Technische Universität München

Design, Implementation and Modeling of a Resonate-and-Fire Neuron

Master's Thesis at the Chair of Circuit Design
(can be combined with a research internship at the chair)

In the context of of intelligent sensor systems, spike encoding of audio signals is of high interest for the development of Spiking Neural Networks (SNN). When dealing with audio-data, it is often advantageous to divide the human audible spectrum into a number of sub-spectra and process each individually before feeding it into a SNN. This process is similar to the function of the cochlea.
Studies have shown, that this can be achieved with Resonate-and-Fire Neurons (RFNs) without much loss of performance compared to classical pre-processing (e.g. Mel-frequency capstrom). Physical RFNs consist of a resonating membrane circuit and an adaptive output comparator. The former locks on to a specific frequency present in the audible spectrum and the latter emits spikes depending on the magnitude of the oscilation.
The main task of your thesis would be implementing both of these circuits.
Additionally, you will model your work within the PyTorch/snnTorch framework to enable SNN learning in the context of keyword detection.



Your work consists of designing and implementing the proposed design in the 22nm GF node. Circuit design will be done with the corresponding cadence design tools at the chair. You will first undertake a scientific literature research on the state of Resonate-and-Fire Neurons. You are then free to come up with your own design and implement it.

Familiarity with the following topics are helpful, but not mandatory:

- analog circuit design
- Virtuso
- Oscillators
- (Spiking) Neural Networks
- Python, Torch and snnTorch

Interested?	→ Contact:	Kilian David kilian.david@tum.de Room N5301