

Appendix A

Questions Catalogue

This is a catalogue of questions as they might appear at the oral exam. Each question is a starting point for a discussion of a particular topic in which knowledge and understanding will be tested.

A.1 Introduction

1. Can you name some differences between a computer and a brain as they were discussed in the lecture?

A.2 Neurophysiology

1. What do you know about tools/methods employed in neurophysiology?
2. What do you know about cortical regions?
3. Can you explain 'topological mapping' in brain areas?
4. What do you know of ocular dominance patterns in V1?
5. What do you know of orientation selectivity patterns in V1?
6. What do you know about the concept of cortical microcolumns?
7. What do you know of cortical layers?

A.3 Basic Analogue CMOS

1. can you explain the characteristics of a field effect transistor (FET)?
2. Can you describe the Early effect?
3. Can you explain a current mirror?
4. Can you explain a differential pair?
5. Can you explain a transconductance amplifier?

6. Can you explain a follower?
7. Can you describe a resistive net?
8. Can you describe a diffuser network implemented with transistors?
9. Can you explain the winner take all circuit presented in the course?
10. Can you explain some extensions of the WTA circuit?

A.4 Real and Silicon Neurons

1. What do you know about the anatomy/physiology of a neuron?
2. Can you explain a Perceptron or Mc Culloch Pitts neuron?
3. Can you describe a Gilbert multiplier?
4. Can you explain the integrate-and-fire circuit presented in the course?
5. Can you describe the adaptive integrate-and-fire circuit presented in the course?
6. Can you explain the firing mechanism of a neuron (compartmental neuron model) according to Hodgkin and Huxley?
7. Can you say something about how to implement a compartmental neuron model into CMOS?
8. Can you describe a compartmental model of a passive cable?

A.5 Coding in the Nervous System

1. Can you describe some physiological experiments that reveal clues on neuronal coding mechanisms? (At least one on rate and one on temporal encoding!)
2. What do you know of neural coding principles?
3. What do you know about the distinction of temporal and rate coding?
4. What distinguishes population and synchrony codes?
5. Can you explain rank order and latency encoding?

A.6 Neuromorphic Communication: the AER Protocol

1. What is the basic principle of AER
2. What do you know about different collision handling concepts employed in AER?
3. Can you explain the arbitration circuit presented in the course?
4. Can you explain the collision detecting/discarding AER receiver presented in the course?
5. Can you describe the principle of the 'aging versus loss' arbitration?

A.7 RetinomorphiC Circuits

1. What do you know about the anatomy/physiology of the eye?
2. What photo active CMOS elements do you know?
3. How can you achieve logarithmic amplification of a photo current?
4. What is a common source amplifier?
5. Can you explain a source follower?
6. Explain the 'active pixel'!
7. Can you describe read out methods for photo arrays?
8. Can you explain one of the two silicon retina circuits presented in the course?
9. Can you explain the non-linear element according to Delbrck?
10. Can you explain the adaptive photo cell?
11. Can you explain token based motion detection?
12. Can you explain intensity based motion detection?
13. Can you explain convolution and feature maps?

A.8 CochleomorphiC Circuits

1. What do you know about the anatomy and physiology of the ear?
2. Can you explain the second order filter used for the silicon cochlea?
3. Can you describe a silicon cochlea?

A.9 NeuromorphiC Learning

1. Can you define 'learning'?
2. What do you know about the main categories of learning algorithms?
3. Can you explain Hebbian learning?
4. Can you explain gradient decent learning?
5. Can you tell something about competitive learning?
6. Can you tell something about spike based learning?
7. What do you know about methods for analog or quasi-analog storage on a CMOS device?
8. Can you explain the DA/AD storage cell presented in the course?
9. Can you explain the high-voltage switch that was presented in the course?
10. What do you know about Fowler-Nordheim tunneling and hot electron injection?

11. Can you explain the bump circuit presented in the course?
12. Can you explain the fusing amplifier?
13. Can you explain 'weak' multi-level memory?
14. Can you describe one of the learning circuits presented in the course (Diorio/Fusi/Häfliger)?