# "Brain Inspired Circuits and Systems"

## Dr Piotr Dudek (University of Manchester, UK)

## Course contents:

The advances in electronic computing of the last 50 years have been facilitated by the steady technological progress in scaling-down of transistor sizes on semiconductor chips. Within the next 10-15 years, however, the scaling process will reach the physical limits, and not only technological advances, but also completely new computing paradigms are needed to ensure that we can sustain the progress and keep designing ever smaller, more capable, and smarter electronic devices. At the same time, recent years have brought great progress in neuroscience, deepening our understanding of the structure and operation of the brain. New computer architectures and brain-inspired information processing systems, based on massive parallelism and complex interactions between simple cells, are already outperforming conventional computers, and pave way towards engineering electronic systems based on nanoscale devices of the future. This lecture course will overview a number of emerging information processing technologies, inspired by the brains, focusing on hardware implementations of these novel computational paradigms. Case studies will be presented drawing from Dudek's extensive research experience in this areas: design of brain-mimicking cortical neuron circuits, memristor-based networks, analog computing, retina-inspired vision sensors, and massively parallel cellular array processor

## Syllabus of the lecture:

1. Introduction. The end of Moore's Law and a rationale for brain-inspired computing (2 hours)
2. Overview of biological systems: Neurons and synapses, Models, Cortex, Visual system (1 hour)
3. Neuromorphic Engineering. Brief history of the field. Analog and mixed-mode computing. Implementing neurons and synapses (2 hours)
4. From circuits to systems: building brains — large scale systems and future outlook (1 hour)

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5. Emerging fabrication technologies. Memristors as synapses. Deep learning networks (2 hours)
6. VisionSensors. Artificial retinas, dynamic vision sensors, pixel-parallel processors (3 hours)
7. Cellular Neural Networks and Cellular Processor Arrays. Architecture and implementation. Programming models (3 hours)
8. Summary and Conclusions (1 hour)

| TERMINY WYKŁADÓW | | | |
|---|---|---|---|
| **Data** | **Dzień tygodnia** | **Godzina** | **Sala** |
| 2015-02-09 | Pn | 10.00-13.00 | 105 NE (Nowy Gmach ETI) |
| 2015-02-10 | Wt | 10.00-13.00 | 105 NE (Nowy Gmach ETI) |
| 2015-02-11 | Śr | 10.00-13.00 | 105 NE (Nowy Gmach ETI) |
| 2015-02-12 | Cz | 10.00-13.00 | 105 NE (Nowy Gmach ETI) |
| 2015-02-13 | Pt | 10.00-13.00 | 105 NE (Nowy Gmach ETI) |