NEW COURSE

Winter 2017

CS 410/510 4/3 Credits, ECE 410/510/507 4/3/1 Credits

Graduate Practicum in Asynchronous Circuits, Systems, and Algorithms

Course Description

In this course we will introduce fundamental concepts for the design of asynchronous circuits, systems, and algorithms. Students will be involved in the development of novel asynchronous systems and prototype implementations, as well as in the development of high-level asynchronous algorithms. Students will simulate and test their designs on an asynchronous system simulator known as RSYAMS, which runs under Windows and Linux. The content of this course is based upon research conducted at Portland State University. Assignments will require approximately 4 hours of work outside of class for each hour of class. This will be a project-based course with student presentations.

The design of asynchronous circuits and systems concerns the construction of circuits without clocks. Such circuits, also known as *self-timed circuits*, are modular and energy efficient because they act only when necessary and as fast as technology allows. Researchers in the Asynchronous Research Center (ARC) have developed a design style consisting of two primitive building blocks, called *Links* and *Joints*. Links move data and accommodate communication delay. Joints act to coordinate the exchange of data between Links. Links and Joints adhere to a simple protocol that defines our underlying model of computation. Compositions of Links and Joints can be combined hierarchically into asynchronous systems of arbitrary size and complexity. Development of a high-level asynchronous algorithm involves finding the parallelism inherent in the computation and mapping it onto a hierarchical composition of Links and Joints. RSYAMS offers a large number of built-in primitives and compositions.

This course is open to both ECE and CS graduate students by permission of the instructors. Undergraduates with significant background will also be considered. Prerequisites include an analytical mind, some knowledge of logic circuits, knowledge of undergraduate algorithms (CS350), and programming experience.

Students interested in taking this course should contact one of the following instructors before December 1, 2016.

Marly Roncken, marly.roncken@gmail.com
Ivan Sutherland, ivans@cecs.pdx.edu
Bryant York, bwyork@pdx.edu

Class will meet on Monday and Wednesday in room FAB 150, 14:00 – 15:50.

Textbook: **No textbook will be required. Lecture notes, simulator documentation, and published articles will be utilized.**

Grades: **CS: P/NP**
ECE: P/NP

Class Format: **Lecture for 50 minutes, followed by Lab for 60 minutes.**

Required Student Work: **Attend lectures/Labs; do the reading assignments; do lab assignments; possibly do An optional term project (a simple asynchronous design)**

List of Topics

1. Introduction to the ARC model (full/empty protocol) for Asynchronous Circuit Design
2. Introduction to the RSYAMS simulation environment for designing asynchronous circuits on Windows and Linux (Raspberry Pi)
3. Principles of Asynchronous Circuit Design
    a. Globally Asynchronous Locally Synchronous
    b. Communication dominates computation
    c. Geometry matter
    d. Communication energy matters
4. Design of Specific Asynchronous Circuits
    a. Kessels' Bounded Response Counter
    b. Other bounded response time algorithms.
    c. Sutherland's Weaver
5. Introduction to Traditional Parallel and Distributed Algorithms
    a. SIMD
    b. MIMD
    c. SPMD
6. Introduction to Dataflow Computing and Asynchronous Distributed Algorithms
7. Introduction of a HAWK-derived functional language for Asynchronous algorithm specification.

Potential Student Projects

1. Design of an Asynchronous NoC
2. Design of an Asynchronous Sorter