IEEE Okanagan Subsection

Presents

Martin Mallinson

ESS Technology

A Short Course on Analog Circuit Design

Session 1: February 25, 2011, Room ASC 130
Session 2: March 4, 2011, Room ASC 140
Session 3: March 11, 2011, Room ASC 140
Session 4: March 18, 2011, Room ASC 140

*All sessions will be presented 3:30 pm – 5:00 pm on UBC Okanagan campus

Course Abstract:

The general theme is to communicate the excitement of electronic design: hopefully some attendees will be moved to learn more. They will have the increased confidence of having seen how relatively easy it is to understand electronic devices when they have the ability to visualize the operation of the circuit. Each presentation will end with a 15-minute interactive question and answer session.

In the first presentation the focus is on creating the "mental model" of how electronic devices operate, largely ignoring detailed mathematics: that mathematics is secondary to an understanding of electronic systems, first comes the "picture" of how the circuit works. We will be able to appreciate simple logic gates easily, we will be able to show how a phase shift oscillator works without any analysis. It will be clear why CMOS Logic has come to dominate digital design. We will learn how to think about a semi-conductor - what exactly is the magic of silicon? Using this hand-waving sense of how devices work will allow us to understand how the most common electronic amplifier works before we reach the end of the first 90 minutes.

The second presentation builds on the first and shows how the tools that the designer uses support the "mental model" of the device operation: why we talk of signals moving up and down, how the design engineer actually spends his or her day at work. We will do real, live design and simulation of some simple CMOS circuits and show what the problems are. We will briefly outline the remarkable "band gap" circuit and how it works. We will look at the ubiquitous "Gilbert Multiplier" and say a little of how designers such as Barrie Gilbert come up with such circuits. We will learn why some circuits are very profitable for companies, and talk a little about the business of electronics. We will speak about the breathtaking advances in electronic manufacturing over my working lifetime - where will it end? We will conclude the second session with a review of the "classic" circuits of electronics: op-amps, PLL's, radio receivers, ADCs and DACs.

The third session begins at a higher level: we have seen how to make elements such as amplifiers from basic FET devices, but a great deal of electronic innovation is at a level above this. What for example, is a Sigma Delta Modulator and why is it important? Where do ideas come from and why is innovation important? This third session is designed to stand on its own and although an integral part of the four sessions, it will be possible for a person interested in the art of innovation to attend just this presentation. We will learn how one of the most difficult aspects of design begins with a steam engine, what the grasshopper escapement has to teach us about electronic systems and why a clock and a bandgap diode are so similar. In this session we will look at a real example, designed right here in Kelowna: the HyperStream modulator and the "Sabre DAC" that uses it - a device that has come to dominate the high-end audio business world wide - what is it? How was it invented? As a part of this we will look at system simulation tools and learn to visualize systems in the frequency domain.

The fourth session returns to electronic devices in detail. How for example, shall we make an audio headphone driver with long battery life? We will look at Class D circuits and how they work with delta modulators, how to measure and optimize an op-amp for low power and low noise operation. Then we introduce the magic of innovation: can we "break the constraint" of this design? Where is innovation good and where is it bad? This session will run real simulations, perform real analysis of the noise, make optimizations and try to remind the designer to always ask exactly why a certain trade-off is present in a circuit. We will end where we began: with our "mental model" of how circuits work we will look at the innovation of others: the Strongarm Comparator, the Cherry Hopper amplifier and a review of the AD797 - one of the world's best op-amps. Why is it so good? This final session ends with a short discussion of the engineering world that the younger attendees may choose to work in: quantum devices are coming - who will design these machines and what do they promise?

Instructor Biography:

Martin Mallinson has been designing silicon chips for the past 30 years in the UK, EU, USA and now Canada. His chips control the engines of jet aircraft, take X-ray images in hospitals, search for underground oil, power the majority of DVD players, and are used in all the latest high end audio equipment. Martin has 47 patents in the USA and more worldwide. He now lives and works in Kelowna and will share his knowledge and methods of CMOS electronic design in a series of presentations designed to show how to think about electronics and design innovative, valuable solutions to real-world problems.

Please contact Julian Cheng (julian.cheng@ubc.ca) for further questions.