ECS Concentration at UCSD

Peter Asbeck, Ian Galton, Drew Hall, Tzu-Chien Hsueh
Patrick Mercier, Gabriel M. Rebeiz

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Overview of Talk

• What is ECS?
• Where will I work?
• What courses to take?
• Should I do an MS and a PhD?
• Professors and their research areas
What is ECS?

• **Electronic Circuits and Systems**
  – Analog circuits (amplifiers, mixers, oscillators, low-power/medical, etc.)
  – Mixed-signal circuits (ADCs, DACs, PLL, etc.), PMIC (power management)
  – RF circuits for communications, radars, sensors (amplifiers, mixers, power amplifiers, etc. at high frequencies - RF/Microwave/Mm-wave)
  – Digital and digital-like circuits (high-speed wireline circuits, VLSI, high speed processors, image processors, etc.)
  – Includes lots of high-frequency PCB layout techniques too

• **Basically, all the chips and systems (RF systems, communication systems, cell phones, base-stations, wireline systems, optical networks, biomedical systems, etc.) which use these chips.**
Where are Circuits and Systems?

- EVERYTHING THAT YOU HAVE OR USE OR DEPEND ON CONTAINS CIRCUITS, LOTS AND LOTS OF CIRCUITS!!! It is a >3Trillion industry in the US. It is ~10% of the US GDP. We are amazing at circuits!!
  - Phones, computers, pads, watches, game consoles, cameras, etc.
  - WLAN boxes, cable boxes, satellite TV
  - Base-stations, cable stations, internet backbone stations
  - Data centers (racks and racks of servers)
  - Cars (!!) – they contain more than 80 micro-controllers today
  - Bio-medical equipment
  - Communication, radar, sensor equipment (commercial and defense)
  - Everything that you touch today contains lots of circuits!!
Where will I work?

- **Electronic Circuits and Systems students are highly paid. One of the highest in EE/ECE (source IEEE)**
- **The US is the #1 country in ECS in the world!!! We design most of the circuits in the entire world. Companies include:**
  - Qualcomm, Intel, Broadcom/Avago, Texas Instruments, Apple, Google, Samsung LSI, MTK, Huawei/Future-Wei, Hi-Silicon, Nokia
  - Analog Devices, Freescale/NXP, Silicon Labs, Qorvo, Skyworks, IDT, Cypress, Maxlinear, MicroChip, Infineon, ST-Micro, Keysight, National Instruments, etc.
  - Intel, AMD, Marvell, Xylinx, Micron, Cadence (VLSI)
  - Inphi, Infinera, Ciena, Broadcom, etc. (optical wireline)
- **Raytheon, NG, Lockheed Martin, Boeing, Qorvo (defense), etc.**
• **Electronic Circuits and Systems (sixty-eight units)**
  • Breadth Courses: ECE 100, 101, 102, 103, 107, 109
  • Depth Courses: ECE 164, 165, 166
  • Technical Electives: five upper-division engineering, math, or physics courses
  • Professional Electives: two upper-division courses
  • Design Course: one of ECE 111, 115, 140B, 190, or 191

• **ECE 164:** Analog Circuit Design
• **ECE 165:** Digital (VLSI) Design
• **ECE 166:** RF/microwave Circuits Design
Electronic Circuits and Systems (sixty-eight units)

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- ECE260ABC, ECE264ABC, ECE265ABC, ECE222ABC (few of them if interested)
- Only if you are really interested – otherwise, take DSP, Random Processes, etc..
Should I do an MS?

• ABSOLUTELY YES!!!!
  • MS results in substantial additional knowledge
  • You will know much more, you will be paid much more!! 😊
  • BS students in circuits end up being test engineers or product support engineers. MS and PhD students end up being the advanced design engineers.

• We recommend that students take (at the grad level):
  – ECE 260ABC  Advanced VLSI
  – ECE 264ABC  Advanced Analog and Mixed-Signal Design (ADCs, DACs, PLLs)
  – ECE 265ABC  Advanced RF Systems, RFIC, Power Amplifier Design
  – Do not forget Antennas, DSP, Random Processes, Digital Comm., Bio-Medical/Low Power, Power Systems, Robotics, etc. (there is lots and lots to learn at UCSD!!).
  – Take a Software or Machine learning course too. You never know when you will need it. This is your time to learn!!
Should I do a PhD?

- It depends on your goals in life 😊
- You will work for 3-4 years getting deep and deep into an area
- It is exciting but it is hard work too!!
- It can lead to a life in R&D, or a life in industry too (lots of companies hire PhDs for advanced design)
- The only path to become a professor, or to be in a high-level position in R&D in industry or government
- Find an area that you like, find an advisor that you like, do some good work, publish a couple of good papers, and voila – you have a PhD!
Power Amplifiers for Wireless Communications

High Power Efficiency
High Bandwidth
High Accuracy

Low Error Vector Magnitude (EVM)
Low Adjacent Channel Power Ratio (ACPR)

How to Get What is Needed

The best semiconductor technology
The cleverest circuits
The best algorithms for digital correction

Envelope tracking
Digital predistortion

Professor: Peter Asbeck
Professors: Drew Hall and Patrick Mercier

Prof. Patrick Mercier:
• Director, Energy-Efficient Microsystems Lab
• Co-Director, Center for Wearable Sensors

Wearable sensors and bio-energy harvesting
Sub-nanowatt wireless sensing systems

Research focus:

Prof. Drew Hall - Injectable “BioMotes” for Continuous Health Monitoring

• Objective: Design a wireless injectable biosensor (a “BioMote”) for continuous, long-term substance abuse monitoring

• Highlight: First-reported sub-1 µW fully-integrated, injectable biosensor reported in the literature
Tzu-Chien Hsueh
Assistant Professor
Integrated Communication Circuits Lab
ECE, UC San Diego

Analog & Mixed-Signal ICs for
- Wireline Communication Systems
- Data Centers & Ethernet
- Electrical-to-Optical Interfaces
- SerDes Links & Broadband Transceivers
- Silicon Photonics

Prof. Ian Galton

Research Emphasis:
Digital calibration and digital-like analog circuits that solve present-day IC limitations. Design ICs with record-setting performance

Example Prior Results:
- Tree-structured dynamic element matching—Used in most mobile phones, many audio CODECs, many TV tuners and cable boxes, and many automotive radar processors
- Adaptive digital gain, mismatch, and nonlinearity calibration techniques—Used in most high-resolution pipelined ADCs
- FDC-based digital PLLs—Used in Snapdragon processor-based phones and soon to be used in high-performance ADI PLL product
- Digitally calibrated VCO-based ADCs with calibration—Soon to be used in multiple radio IC products
24 GHz CMOS Rx phased array
35 GHz SiGe Tx-Rx phased array

80 GHz 16-element phased array with BIST (R&D100 Award, Microwave Prize)

150 GHz CMOS T/Rx with 20 Gbps

Automotive phased array radars for autonomous vehicles

79 GHz E-plane

36 GHz SiGe CMOS phased array with BIST (R&D100 Award, Microwave Prize)