Update: Proposed CE Curriculum & Program

Bruce Jacob, End of Summer 2008
What’s all this, then?

Charge:
- Improve curriculum and/or program
- Increase enrollment & visibility

Activity:
- Polled faculty, students, graduates
- Held constituents’ meeting over winter
- Group vote ➔ this curriculum/program
- Development of syllabi for new courses
Proposed Changes

• 499 credit for appropriate internships

• Cat ‘F’ requirements = those of EE degree

• Definition of “tracks” within program … related sets of electives, for example:
  ○ Hardware, VLSI design, microelectronics
  ○ Real-time systems, controls
  ○ DSP hardware/software, signal processing
  ○ Software, theory, CS stuff

• Curriculum changes, both required & optional/elective
Freshman Year (7/8 +1 Required Courses)

Physics 161
Calculus I
Calculus II
(Can we eliminate Chem requirement?)
ENES 100
ENEE 140 (C programming I, can place out)
ENEE 150 (C programming II)
   note: alternative path CMSC 131, 132, 212
ENEE 241 (Numerical techniques) — modification
   focus: linear algebra, diff EQ’s, transforms
ENEE 244 (Logic design)
ENEE 1xx (Intro to Computer Engineering) — new
   1 credit seminar/lab: tracks, soldering, etc.

Sophomore Year (8 Required Courses)

Physics 260
Physics 261
ENEE 204/206 (Analog circuits analysis & lab)
ENEE 350 (Computer organization)
ENEE 359a (VLSI design) — modification
   focus: transmission line analysis + VLSI design
ENEE 2xx (Algorithms & data structures) — new
ENEE 2yy (Probability & stats, replace 324) — new
ENEE 2zz (Digital design & FPGA lab) — new

Junior Year (6 Required Courses, 2 Electives)

ENEE 303 (Analog circuit design)
ENEE 307 (Analog circuits lab)
Optional: CMSC 322 (theory/research track)
ENEE 3ww (Compiler design) — new
   Rajeev Barua
ENEE 3xx (Digital systems) — new
   Based on Dally & Poulton
ENEE 3yy (Embedded real-time systems) — new
   May be what Ganssle & Barr teach
ENEE 3zz (Operating systems) — new
   May be satisfied by revamp of CMSC 412
   + 2 Electives

Senior Year (0 Required Courses, 8 Electives)

Capstones and Electives (i.e., tracks)

Total courses: 31/32 +1, plus CORE
Freshman Year

- Physics 161
  Calculus I & II
  (Eliminate Chem requirement?)
  ENES 100

- ENEE 140 (*C programming I, can place out*)
  ENEE 150 (*C programming II*)
  Note: alternative path via CMSC 131, 132, 212
  ENEE 241 (*Numerical techniques*) — requires modification
    Focus: linear algebra, diff EQ’s, transforms … enough for 204/206
  ENEE 244 (*Logic design*)

- ENEE 1xx (*Intro to Computer Engineering*) — new course
  A 1-credit seminar/lab: discussion of tracks, teach soldering, etc.

- 7/8 +1 Required Courses
Sophomore Year

- Physics 260
  Physics 261

- ENEE 204/206 (Circuit analysis & lab)
  ENEE 350 (Computer organization)
  ENEE 359a (Digital VLSI design) — requires modification
    Focus: transmission-line analysis + VLSI design

- ENEE 2xx (Algorithms & data structures) — new course
  Part of the material will be taught in C programming II,
  but this course needs algorithms, data structures, and discrete math

- ENEE 2yy (Probability & statistics, to replace 324) — new course
  Either new course or teach 324 the way Gang Qu does

- ENEE 2zz (Digital design & FPGA lab) — new course
  To replace the digital component of 204/206 that was removed

- 8 Required Courses
Junior Year

• ENEE 303 (*Analog circuit design*)
  ENEE 307 (*Analog circuits lab*)

• ENEE 3ww (*Compiler design*) — *new course*
  Rajeev Barua has agreed to develop and teach the course

• ENEE 3xx (*Digital systems*) — *new course*
  Bruce Jacob has agreed to develop and teach the course

• ENEE 3yy (*Embedded real-time systems*) — *new course*
  This may simply be the course that Barr & Ganssle teach

• ENEE 3zz (*Operating systems*) — *new course*
  This may be satisfied by a revamp of CMSC 412

• 6 Required Courses, 2 Elective Course
Senior Year

- **Capstones** and **Electives** (i.e., tracks)

New CE-oriented capstones proposed:

- Consumer electronics
- Applications engineering
- ENES 100 follow-up

- 8 Elective Courses

**Total Courses over four years: 31/32 + 1 (plus CORE)**
To-Do List

• Institute proposed rules (cat ‘F’ classes, etc.)
• Proposed courses: develop syllabi, offer/teach
• Oversee changes to existing courses (if nec.)
• Articulate & describe curriculum tracks
• Adopt new curriculum once syllabi in place
• Develop CE-program website
More detail on courses
Course changes

ENEE 241 (Numerical techniques)

For computer engineers, this class should serve as a mathematics prep for ENEE 204/206 and possibly ENEE 322. The only topics required by CEs are linear algebra, differential equations (at the level used in 204/206), signals basics, and possibly transforms. Either replace this course in the curriculum with Math 461, or teach 241 as follows:

- Basic linear algebra: matrix arithmetic, inversion, determinants, Gaussian elimination
- Basic differential equations: ability to solve simple 2nd-order problems
- Signals basics: frequency domain, phasers
- Basic transforms (optional?)
Course changes

ENEE 303 (Analog circuit design)

We must ensure that the focus of this course is on circuits and not device physics. Significant discussion of device physics must be restricted to ENEE 313.
Course changes

ENEE 324 (Probability & statistics)

Computer engineers need more statistics and probability, and less communications-specific mathematics. The course should be taught the way that Gang Qu teaches it, or we should develop a new course to satisfy the needs of the CE program (see ENEE2yy below).
Course changes

ENEE 359a (Digital VLSI design)

This course currently covers VLSI design and system-level design concepts (timing, synchronization, chip-to-chip communication methodologies, etc.). In addition, a significant part of VLSI design requires understanding of transmission-line analysis (e.g. RC time constant, characteristic impedance, etc.), which is currently taught at the junior year and not in the context of circuit analysis. There is not time in this course to do a full coverage of systems concepts, and the coverage of systems concepts precludes an effective tutorial on transmission-line analysis.

Our solution: we will develop a new course to cover system-level concepts (see ENEE 3xx, below), we will move that material out of this class, and we will teach transmission-line analysis in this class.
Course changes

CMSC 412 (Operating systems)

The CS course in operating systems has recently adopted a significantly higher-level focus. Previously, its focus was on the interaction between the hardware and system-level software. It is now more focused with file-system design, process management, etc. We desire a return to the original focus.

An important data point is that this class is taken almost entirely by CE majors, not CS majors. For whatever reason, CS majors are less interested in the topic than CE majors (it is a requirement for the CE degree and not the CS degree). This should be justification for CS to teach the course in the manner that best suits the CE program. If CS is unwilling to teach the class as before, we can develop our own class (see ENEE 3zz, below).
New courses

**ENEE 1xx (Intro to CE)**

This is a freshman-level 1-credit seminar/lab intended to give a broad introduction to the field of computer engineering. Topics would include the large issues facing the discipline in the near future, employment prospects (e.g., day-in-the-life descriptions), discussion of the various tracks in the curriculum, proper techniques for soldering, simple circuit-board design, basic computer concepts, etc.
New courses

ENEE 2xx (Algorithms & data structures)

Topics to be covered:

- algorithms
- data structures
- discrete math
New courses

ENEE 2yy (Probability & statistics, to replace 324)

This requires either a new course, or teach 324 the way Gang Qu does.
New courses

ENEE 2zz (Digital design & FPGA lab)

To replace the digital component removed from 204/206

A projects-based course that teaches how to build larger digital components than what is covered in 244. Based on Smith & Franzon’s *Verilog Styles for Synthesis of Digital Systems*. Example projects:

- Crossbar switch
- Iterative multiplier
- SRAM array (or cache)
- DRAM memory controller
- Microprocessor

**Note:** Requires physical resources (lab with appropriate equipment, support)
New courses

ENEE 3ww (Compiler design)

Focus: back-end concepts as well as parsing

Rajeev Barua has agreed to develop and teach the course
New courses

ENEE 3xx (Digital systems)

Based on texts such as Dally & Poulton’s Digital Systems Engineering, Johnson & Graham’s High-Speed Digital Design, and Buchanan’s Signal and Power Integrity in Digital Systems. Bruce Jacob has agreed to develop and teach the course. Proposed topics:

- Signaling (current mode, voltage mode, termination, single-ended, differential)
- Timing (jitter, skew, eye diagrams & margins, encoding, open- and closed-loop timing, clock distribution)
- Synchronization (synchronous, asynchronous, crossing clock domains, synchronizers)
- Power & power distribution
- Noise (crosstalk, ISI, ground bounce, power supply noise, etc.)
- Interconnects (wires)
- Packaging (ICs, PCBs, chassis & connectors)
- System analysis
New courses

ENEE 3yy (Embedded real-time systems)

This may simply be the course that Barr & Ganssle teach.
New courses

ENEE 3zz (Operating systems)

This may be satisfied by a revamp of CS412.