Experiences with a Signals First Approach to the EE Curriculum*

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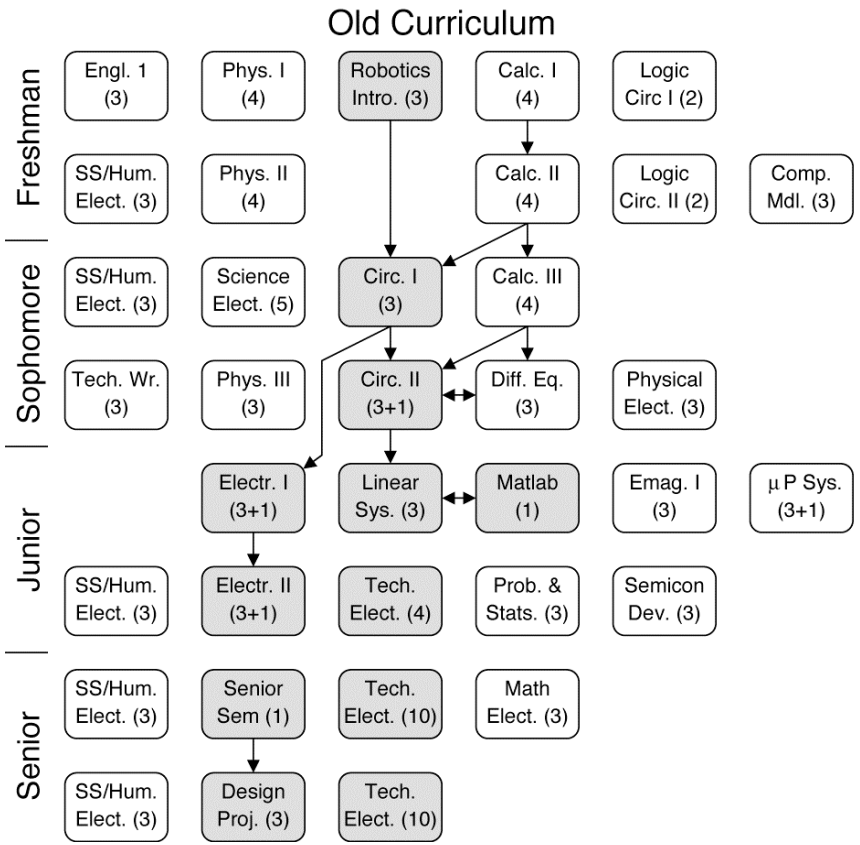
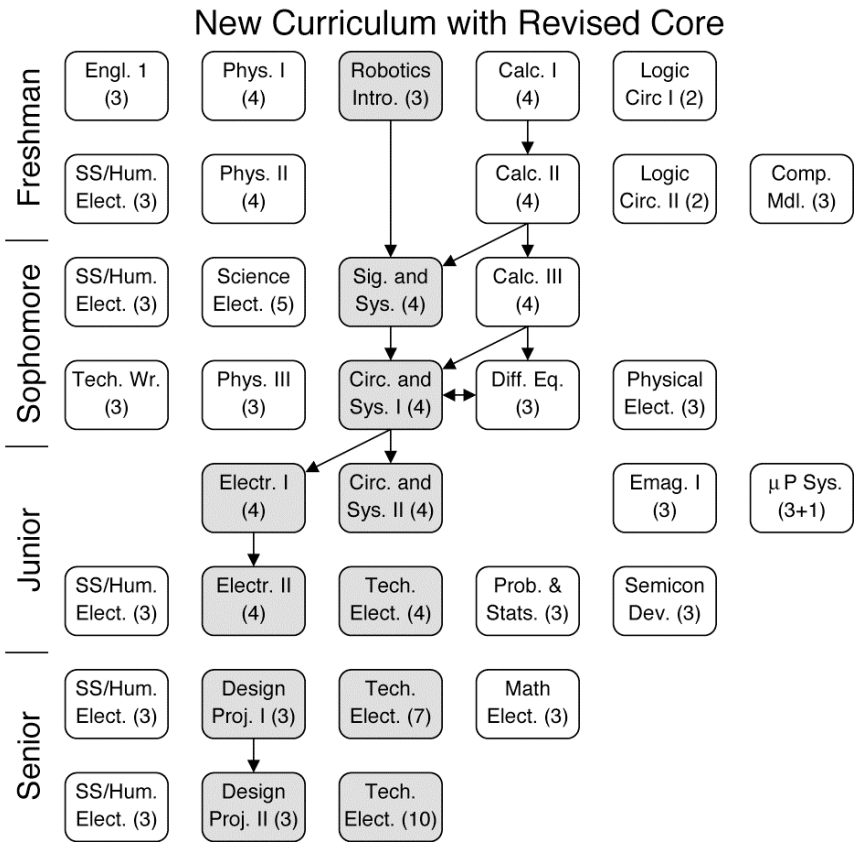
History and Motivation

- Began redesign of our circuits/systems curriculum in 2004 with writing and award of an NSF grant; eventually will encompass 38 sem hours
- Multiple goals
  - Appeal to students' interest in and use of modern devices such as iPods, CD players, cell phones, etc.
  - Address multiple learning styles – sensing/feeling, watching, thinking, doing (Kolb – perception and processing)
  - Encourage motherhood and apple pie – lifelong learning, under-graduate research, more and varied writing experiences earlier, etc.
- About six months into the NSF grant, decided to go with the "signal processing first" approach of Ga Tech and others
  - Taught "Intro to Signals and Systems" for the first time in fall 2005, second time in spring 2006.
  - Follow-on circuits course taught in spring 2006 (Ga Tech authors)
  - Second circuits/signal processing course to be taught fall 2005
  - Courses are packaged in a four-semester-hour format (two periods lecture; one period lab per week)
- Really based on successful experience with freshman robotics course appealing to a variety of learning styles

Old and New Curricula Compared

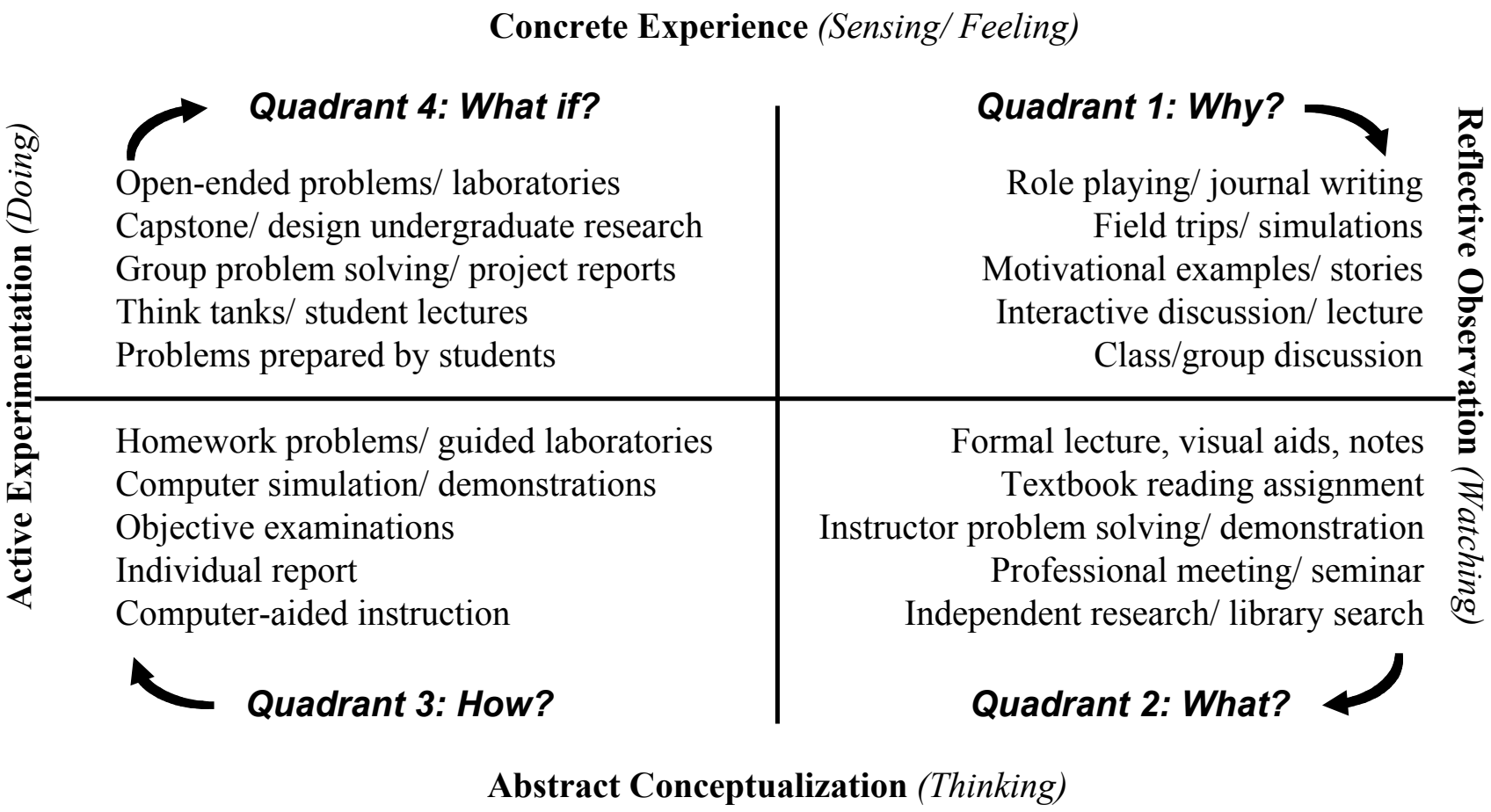




Schedule: *Intro to Signals & Systems*

Monday	**Wednesday**	**Friday**
Ch 1: Introduction	Ch 2: Sinusoids	Lab 1: Intro to MATLAB
Ch 2: Sinusoids	Ch 3: Spectrum representation	Lab 2b: Complex exponentials
(Labor Day)	Ch 3: Spectrum representation	Lab 3: AM and FM signals
Ch 3: Spectrum representation	Ch 4: Sampling and aliasing	Lab 4: Synthesis of sinusoidal signals
Ch 4: Sampling and aliasing	Ch 5: FIR filters	Lab 4: Synthesis of sinusoidal signals
Ch 5: FIR filters	Ch 5: FIR filters	Lab 6: Digital images; A/D and D/A
Ch 6: Freq. resp. of FIR filters	Ch 6: Freq. resp. of FIR filters	Lab 6: Digital images; A/D and D/A
Ch 6: Freq. resp. of FIR filters	*Review for midterm*	Lab 7: Sampling, convol., FIR filtering
Midterm Examination	Ch 7: z-transform	Lab 7: Sampling, convol., FIR filtering
Ch 7: z-transform	Ch 8: IIR filters	Lab 8: Freq. resp: bandpass/nulling
Ch. 8: IIR filters	Ch 8: IIR filters	Lab 8: Freq. resp: bandpass/nulling
Ch. 8: IIR filters	Ch 9: Continuous-time signals & syst.	Lab 9: Encoding/decoding TT signals
Ch 9: Continuous-time signals & syst.	Ch 9: Continuous-time signals & syst.	Lab 9: Encoding/decoding TT signals
Ch 10: Cont. time frequency response	*(Thanksgiving)*	*(Thanksgiving)*
Ch 11: Fourier transform	Ch 11: Fourier transform	Lab 11:PeZ, a, n, omega domains
Ch 11: Fourier transform	Ch 12: Applications	*Final project due*

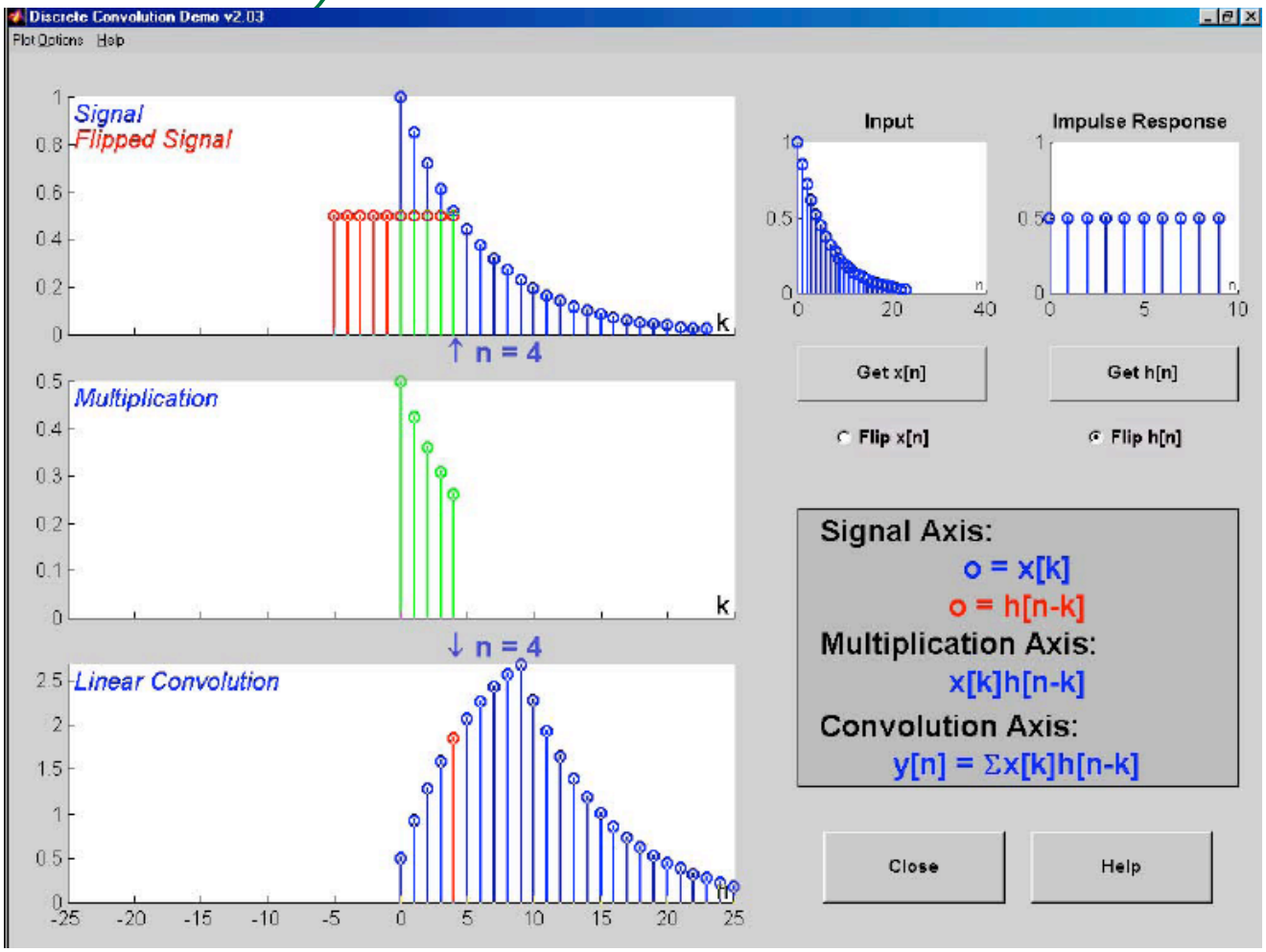
Kolb 4MAT Learning Cycle



Intro to Signals and Systems Compared with Kolb Cycle

- Quadrant 1: Why?
  - Motivational examples in lecture sessions
  - Examples in lab (inverse FIR filter for echo and image blurring)
- Quadrant 2: What?
  - Lectures
  - Visual aids on CD
  - Handouts
  - Solved examples by instructor, in book, on CD
- Quadrant 3: How?
  - Homework problems and weekly quizzes (solutions provided)
  - Lab reports (prelab and formal)
  - Computer aids for labs and lecture material (on CD)
- Quadrant 4: What if?
  - Project (noisy speech signal with echo; design filters to enhance)
  - Some aspects of lab experiments

Example GUI from *Signal Processing First* (dconvdemo)



Survey and Anecdotal Data from "Signals and Systems"

- Used a student-scored survey instrument. Fall 2005/spring 2006 percentages in parentheses (about 1/3 of class responded each offering):
  - active vs reflective learners (75%)(57%)
  - sensing vs intuitive learners (75%)(43%)
  - visual vs verbal learners (75%)(71%)
  - sequential vs global learners (63%)(30%)
- Anecdotal results
  - Come into course knowing trig; applying it a challenge
  - Workload heavy – for both professor and student
  - First part of course a challenge; z-transform and on easier
  - Students' performance rose to level of expectations

Schedule: *Circuits and Systems I*

Monday	**Wednesday**	**Friday**
(Martin Luther King Observance)	Ch 1: Circuit elements and models	Lab 1: Digital multimeter
Ch 1: Circuit elements and models	Catch-up day in lab	Lab 1: Digital multimeter
Ch 1: Circuit elements and models	Ch 1 & Ch 2: Writing circuit equations	Lab 2: Kirchoff's laws
Ch 2: Writing circuit equations	Ch 2: Writing circuit equations	Lab 2: Kirchoff's laws
Ch 2: Writing circuit equations	Ch 3: Subnetworks	Lab 3: Oscilloscope
Ch 3: Subnetworks	Ch 4: Operational amplifiers	Lab 3: Oscilloscope
Ch 4: Operational amplifiers	Catch-up day in lab	Lab 4: Simple op-amp circuits
Ch 4: Operational amplifiers: *L, C*	Ch 4: Op-amps: 1^{st} & 2^{nd} order sol'ns	Lab 4: Simple op-amp circuits
Catch-up day in lab	Ch 4: Op-amps: 1^{st} & 2^{nd} order sol'ns	Lab 5: Complex op-amp circuits
Ch 4: Op-amps: 1^{st} & 2^{nd} order sol'ns	*Midterm Examination*	Lab 5: Complex op-amp circuits
(Spring break)	*(Spring break)*	*(Spring break)*
Ch 5: Laplace transform	Ch 5: Laplace transform	Project in lab
Ch 6: Circuits in the Laplace domain	Ch 6: Circuits in the Laplace domain	Project in lab
Ch 6: Circuits in the Laplace domain	Ch 6: Circuits in the Laplace domain	Project in lab
Ch 6: Circuits in the Laplace domain	Ch 7: System functions	Project in lab
Ch 7: System functions	Ch 7: System functions	*Demonstrate project in lab*
Ch 7: System functions		

Schedule: *Circuits and Systems II*

Monday	**Wednesday**	**Friday**
Ch 8:Sinusoidal input signals	Ch 8:Sinusoidal input signals	Lab 1: Warmup
Ch 8:Sinusoidal input signals	Ch 8:Sinusoidal input signals	Lab 1: Lab
(Labor Day)	--: AC power/transformer circuits	Lab 2: Warmup
--: AC power/transformer circuits	--: AC power/transformer circuits	Lab 2: Lab
--: Fourier transform review	Ch 9: Frequency response (Bode)	Lab 3: Warmup
Ch 9: Frequency response (Bode)	Ch 9: Frequency response (Bode)	Lab 3: Lab
Ch 9: Frequency response (Bode)	--: Active feedback example; Routh	Lab 4: Warmup
--: Active feedback example; Routh	Ch 10: (Analog) Filter circuits	Lab 4: Lab
Midterm Examination	Ch 10: (Analog) Filter circuits	Lab 5: Warmup
Ch 10: (Analog) Filter circuits	Ch 10: (Analog) Filter circuits	Lab 5: Lab
Ch 10: (Analog) Filter circuits	Ch 10: (Analog) Filter circuits	Lab 6: Warmup
--: Signal processing review	--: Digital filter design	Lab 6: Lab
--: Digital filter design	--: Digital filter design	Lab 7: Warmup
--: Digital filter design	*(Thanksgiving)*	*(Thanksgiving)*
--: Hybrid system integration	--: Hybrid system integration	Lab 7: Lab
--: Hybrid system integration	--: Hybrid system integration	*Final project due*

Future Plans

- Teach *Circuits and Systems II* for the first time fall semester, 2006 – much development yet to do
- Propagate the format developed for *Intro to Signals and Systems, Circuits and Systems I & II* to following courses – *Electronics I & II*
- Start developing substance for one thread: *Robotics* or *Wireless*