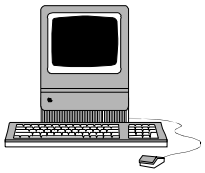
Curriculum Revision

Increasing the place of Information,Signals and Systems early on in our EE (CE/SE) curriculum

G. de Veciana

References:
Lee & Messerschmitt article on Engineering the Future
Lee & Varaiya textbook under development
‘‘The structure and interpretation of signals and systems"

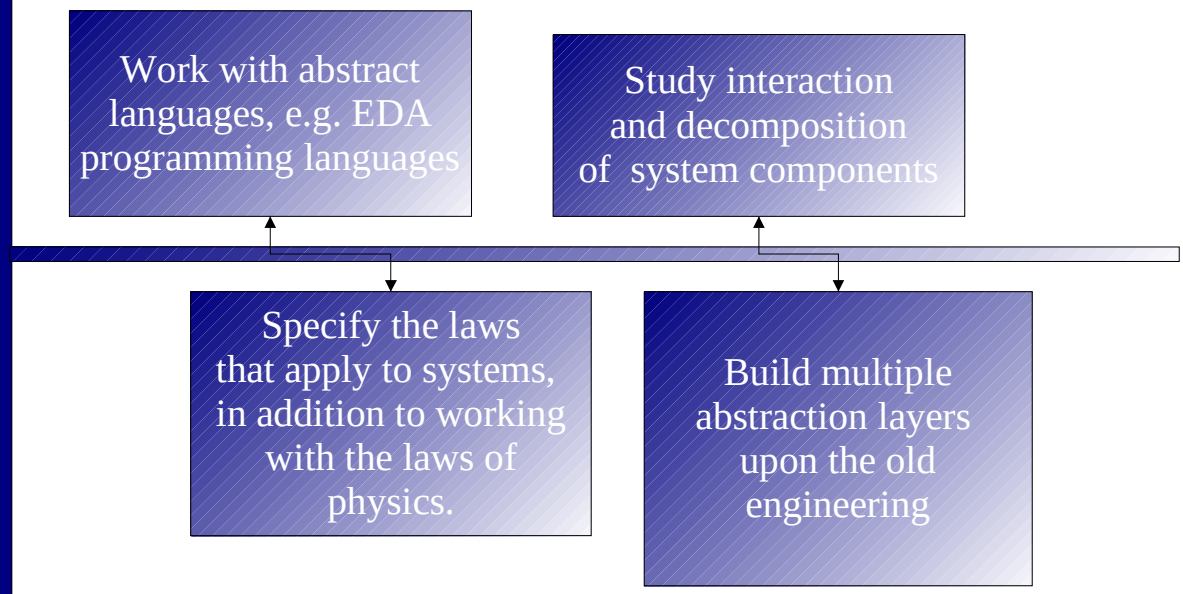


Why bother

- Olde EE:
  - coercing physical devices to do man’s bidding
  - constraints: laws of physics
- New EE –> ‘‘Electronic Information Systems"
  - coercing abstract human constructs and artificial systems to do..
  - constraints
    - complexity, computability, logic
    - human factors, regulation, economics
    - limited knowledge domain

A new profile : BS in EE (CE/SE)

Same for EE/CS/SE ?



Eg. TCP/IP simple user protocols <−−engineering−> macroscopic system level interactions

EE at U.T. Today

- Our required undergrad curriculum in signal and system includes
  - Signals and Systems− continuous−time and (recently) discrete−time signals
  - Automatic Control− feedback control
  - Probability, Statistics and Random processes −

What is missing?

- Early (integrated) exposure to range of modeling techniques
  - signals => continuous/discrete time, and streams (no time), discrete events
  - system modeling => LTI systems and discrete event systems, FSMs, Markov Chains, heterogenous/hybrid systems
  - rigorous formulation/abstraction of system models
- Broader exposure to information processing and applications domains
  - from signals −> bits −> packets −> network systems
  - compression, encryption, information theory
  - control, commerce, medical, etc.

How do we accomplish this

- Revise our basic math sequence ?
  - Sure but is this pushing the work to another department..
- Revise our basic intro courses:
  - EE 302 information, signals and systems ?
- Revise other courses accordingly e.g.,
  - EE313
  - EE351k

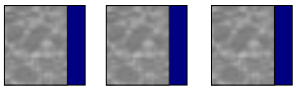
How do we accomplish this

Mathematical Foundations for new EE

- Currently we have
  - Calculus 1 and 2, diff eq, linear algebra
  - probability, statistics and random processes

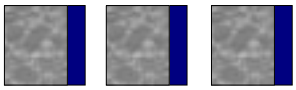
would be nice to add

  - numerical methods, optimization
  - discrete math, combinatorics, graphs
  - logic, topology, partial orders



Proposed Solution

- Premise: We still need two courses for calculus. (for students entering EE I would hope this is debatable..)
- Proposal:
  - Two courses on calculus
  - Mathematics for Engineers 1: diff equations, numerical methods, linear algebra − matlab...
  - Mathematics for Engineers 2: logic, set theory, discrete math, partial orders ...



Proposal's Impact on Curriculum

- Minimum change scenario:
  - development of course combining basic differential equations with linear algebra − matlab? This consolidates the diff equation and linear algebra requirements.
  - Add discrete math to EE curriculum

How do we accomplish this

EE 302 includes topics in

Information, Signals and Systems

- Currently EE 302
  - digital and analog circuits + other stuff (apologies to instructors)

is it feasible to evolve towards

  - digital and analog processing of information
  - or even, structure of signals and systems ...?

Specific Topics to Include in EE 302 ++

- Examples of signals and systems
- Signals as functions and function composition
- Systems as functions − differential/difference equations, state machines composing systems using block diagrams
- State−space models − state machines, FSMs, non−deterministic
- Composing State machines− synchrony, cascade, product, feedforward, feedback..

Maybe =<5 weeks worth of material ?

Bottom line.. what do I propose to add to EE 302 ++

- Fundamentals
  - Definition of a function
  - Signals/streams as functions
  - Systems as functions
  - Composition of systems as composition of functions

and

- Exposure to various types of ‘‘real" systems and signals and the power of formal system modeling

Proposal's Impact on Curriculum

- Is this feasible?
  - To teach this early in their careers:
    - cant say but EE20 UCB text is more ambitious.
    - Material there could help with the development of new ''modules'' for ee 302
  - To implement : What material leaves ee302?
    - reduce required circuit material
    - Circuits (and electronics) will be covered in EE 411
    - Digital material left for EE 316
    - EE 313 Signals and Systems − could/should be broadened − see next slides

Other comments/proposals

- EE 313 = signals and systems
  - should touch on control and communications principles: feedback, stability, modulation
  - do we need required communications and control courses for all students or should these be electives?
- EE351K − can be improved ?
  - add Markov chains, they are fun and applicable to all EE/CE/SE
  - simulation, system design problems ?
  - What topics will we have to give up here ?

In summary

- Revise our basic math sequence ..
- Revise our basic intro courses...
  - EE 302 information, signals and systems ?
- Revise other courses accordingly e.g.,
  - EE 313 − Signals and Systems
    - take the time to discuss communications and control systems apps
    - for DSP students take an elective course
  - EE351k − add some MC modeling, system design problems..., simulation would be nice..

What goals would we meet..

- Small step from circuits to information systems at the base of our curriculum => big payoff (?)
- Develop abstract modeling skills for systems and motivate the math and upcoming courses
- Bridge the system concepts to various disciplines EE/CE/SE and application domains
- Better and broader preparation of undergraduate student, for work and/or graduate school