ESE Course Faire (and adjacent)

Spring 2014

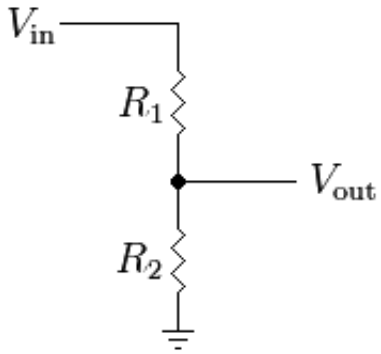
(For Fall 2014)

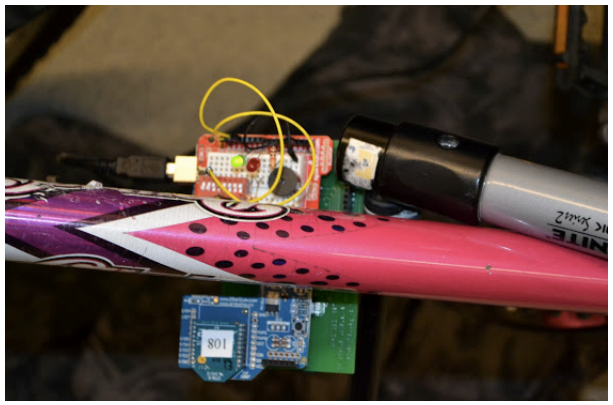
ESE111: Atoms, Bits, Circuits, Systems

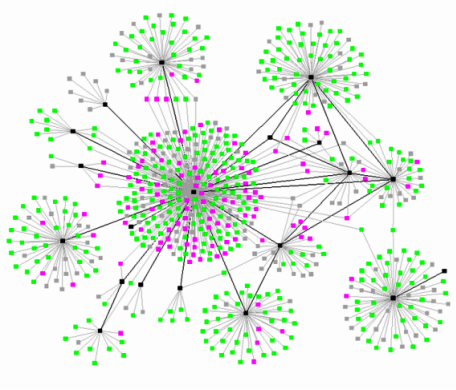
http://www.seas.upenn.edu/~ese111/

- **Introduction to ESE:** Fall, Freshmen only with no prerequisites
- 1 CU with alternating lecture and laboratory
- Covers concepts in VLSI, circuits, information, networks, energy, systems, entrepreneurship with hands-on labs based on programming of embedded systems.

New 2014: systems section





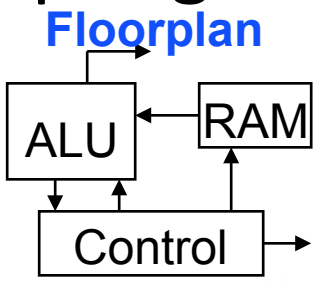


ESE170: Principles of Digital Design

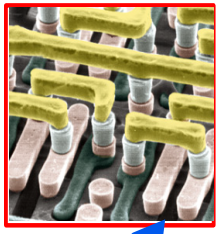
Spring

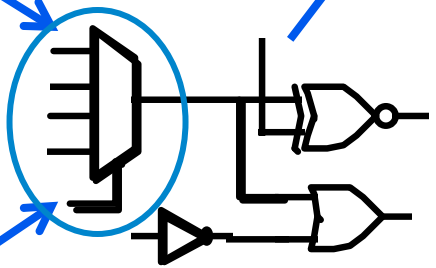
http://www.seas.upenn.edu/~ese170

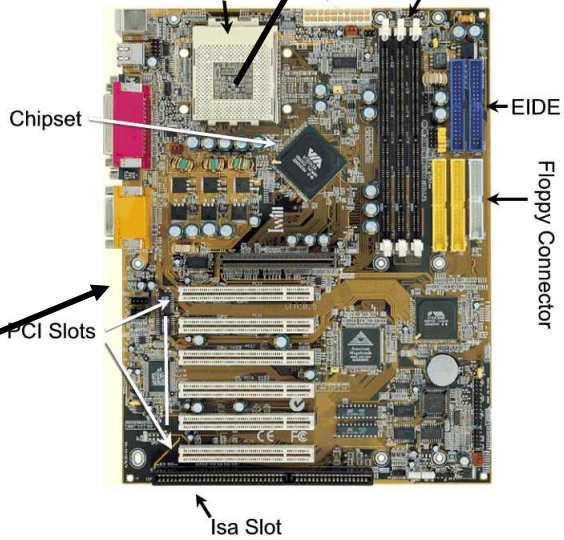
- Operation and design of the main building blocks of a computer and modern digital systems
- No Pre-reqs, Spring

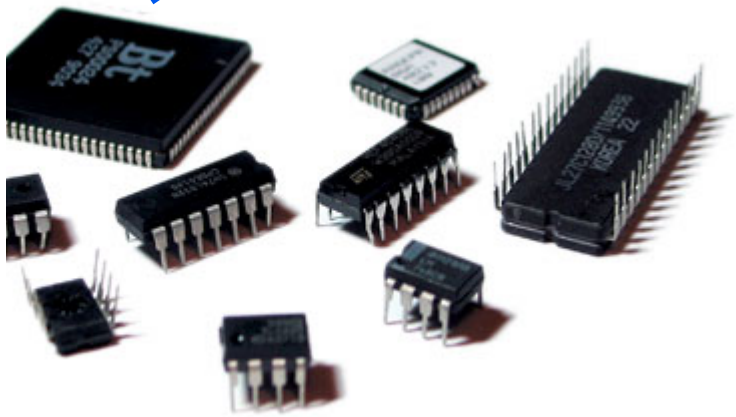



(Intel)





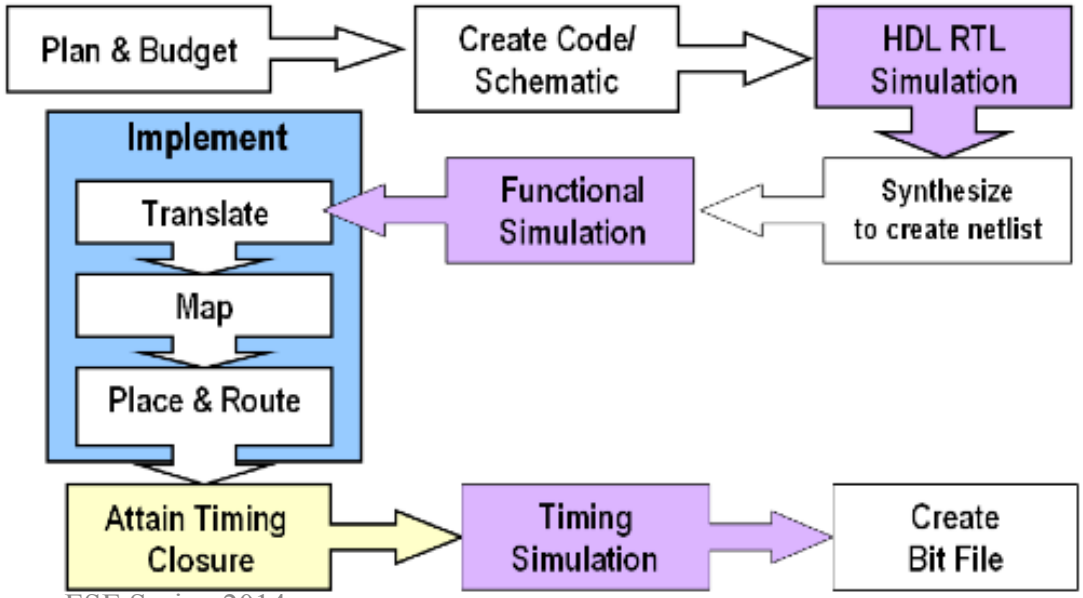


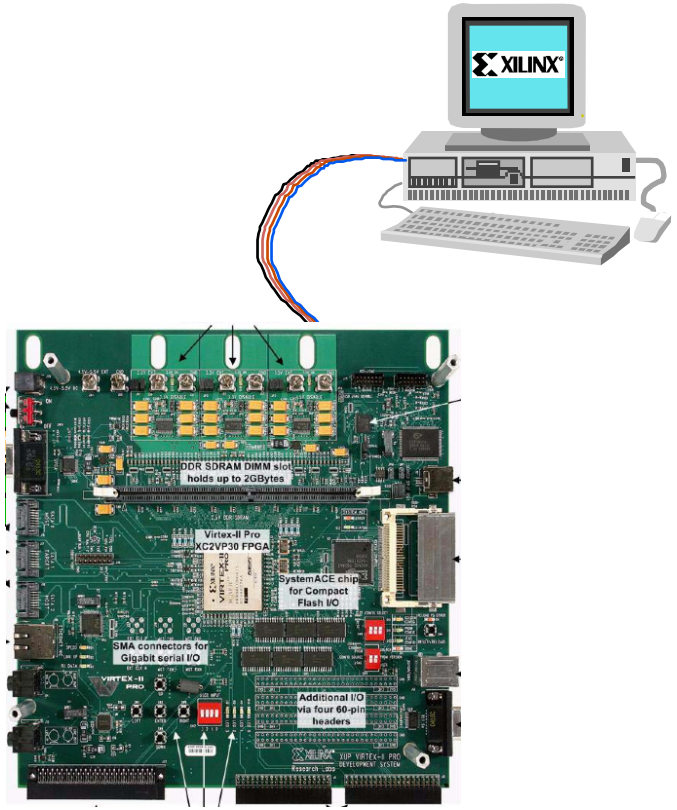


ESE171: Principles of Digital Design

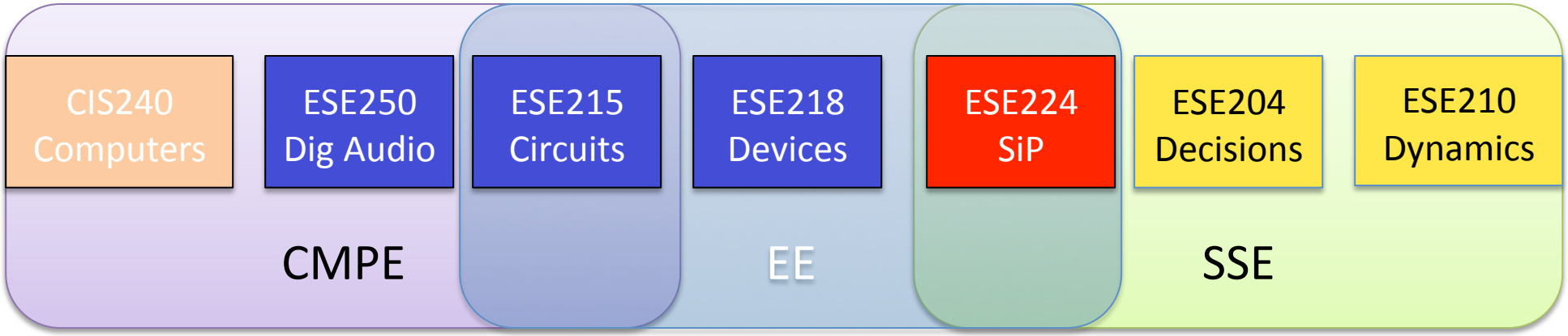
http://www.seas.upenn.edu/~ese171

- Learning to systematically design, simulate and test digital systems
- Using state-of-the-art Computer Aided design
- Use of schematic entry and hardware design language (VHDL)
- 0.5 CU's
- Companion course of ESE170, Spring





Sophomore Core Courses



ESE 204: Decision Models

Entryway to Info & Decision Systems area for Systems majors.

For freshmen & sophmores.

Learn how simple quantitative models can yield deep qualitative insights in a variety of settings:
Production planning, portfolio planning, risk management, transportation and yield management

Will use MATLAB, Excel SOLVER add-in and @Risk.

New Instructor: Vohra

ESE 210: Intro to Dynamic Systems

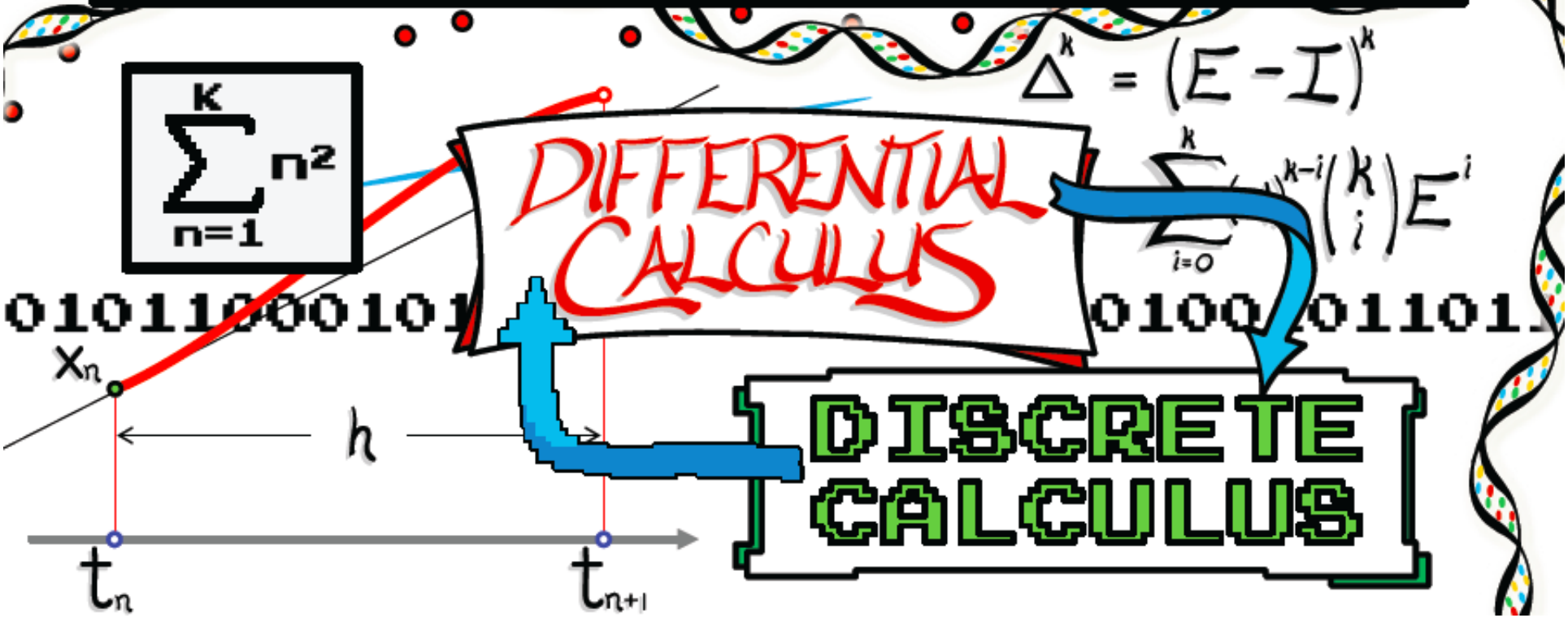
Prof. Ghrist

Fall 2014

Modeling/analysis of systems

Electrical, biological, economic

Co-requisite: MATH 240



ESE224: Signal and Info Processing

Penn
University of Pennsylvania

Topics

- Signals, Systems, Linear Time Invariant
- Fourier, DTFT, DFT
- Sampling, DSP
- FIR
- Random signals
- Least Squares, Kalman
- Adaptive
- Signal classification
- Multidimensional Fourier
- Image filtering
- Radon, MRI
- PCA

LAB

- Audio tones
- Music synthesizer
- Digital clarinet
- Noise and signal separation
- Dow Jones tracker
- Text recognition
- Image blurring
- MRI
- Migration patterns from DNA

New Course
Spring 2015

Penn Engineering

ESE218: Electronic, Photonic, and Electromechanical Devices

Topics

- Semiconductor electronic and optical, fabrication
- LEDs, Lasers
- Photonics, Photovoltatic
- Transistor and memory devices
- Waveguides, fibers
- Transmissions lines and antennas
- Imaging and Sensing
- Electric and Magnetic fields
- Actuators
- Sensors and transducers
- Electromechanical operation and manufacturing

LAB

- LEDs
- Photovoltaics
- Semiconductors
- Transistors
- Optical fibers
- Antennas
- Imaging/Sensing
- Microelectromechanical actuator
- Silicon microphone

Significantly revamped

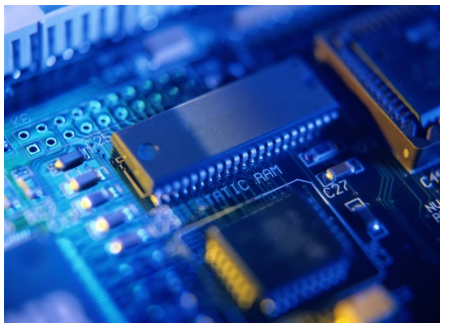
1.5CU

New Instructor: Kagan

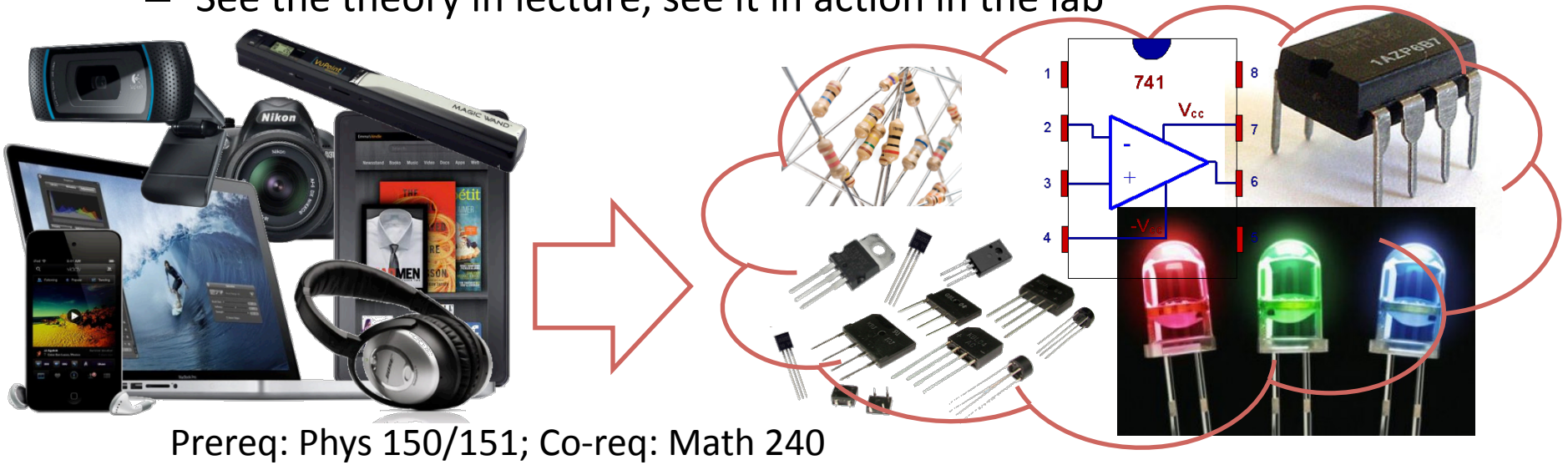
Expanded Content

ESE 215: Electric Circuits

resistors to transistors and more…



- Learn about RLC circuits/amplifiers/LEDs/transistors
  - The basic components in all electronic devices
  - *From your smart phone to CPUs, to your tablet!*
- Learn techniques to analyze any electric circuit
  - Build a solid foundation by learning basic engineering analysis
- Lab integrated into weekly lectures
  - See the theory in lecture, see it in action in the lab



Prereq: Phys 150/151; Co-req: Math 240

ESE215: Circuit Design

Penn
University of Pennsylvania

Topics

- DC, KVL/KCL; Nodal, Mesh
- Superposition
- RC, RL, RLC
- AC, phasors
- OpAmps
- Freq. response
- MOSFET
- Simple gates, comb. Logic
- MOS transistor circuits

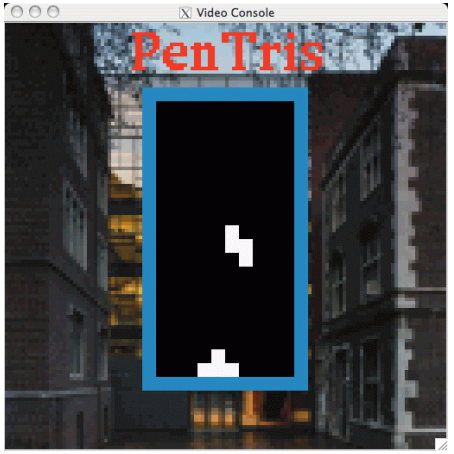
LAB

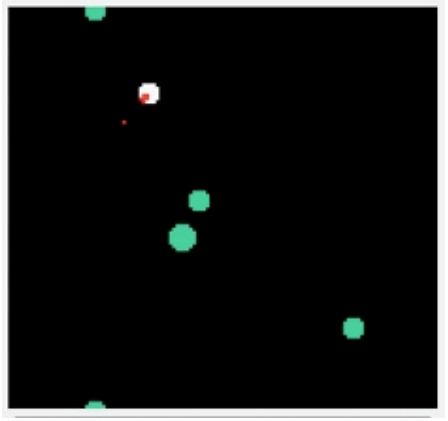
- Lab equipment
- Current limit, resistors, LEDs
- AC waveforms, PWM
- RC+multisim
- OpAmps
- Step response
- Digital logic from transistors
- Band-pass filter
- MOSFET bias and amplification

Penn Engineering

CIS240: Introduction to Computer Systems

- Prerequisite: CIS110
- Bottom-up, no-magic intro to systems
  - Data representation (1s and 0s)
  - Digital logic and hardware
  - Low-level programming *and* debugging
  - Compilers, operating systems, security
- Three programming projects
  - Operating system calls: in assembly
  - Game (Tetris, Maelstorm): in C
  - Binary utility: in C
- Now offered Fall and Spring

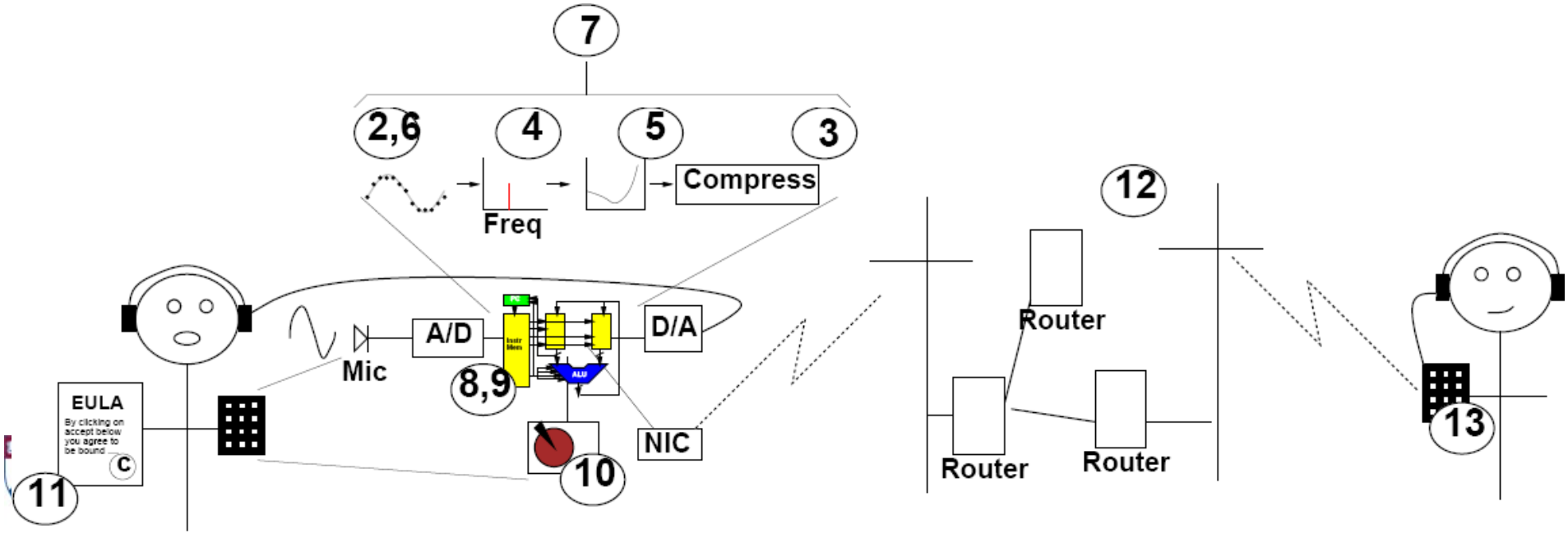




ESE250: Digital Audio Basics

http://www.seas.upenn.edu/~ese250/

- **Informally:** Understanding iPod/iPhone -- overview of the technology behind cell phones and MP3 players
- 0.5 CU – weekly hands-on-lab
- Pre-req: some programming (e.g. CIS110)
- Spring 2015



Specialization Math

- ESE 301 – CMPE, EE, SSE
  - Offered only in Spring 2015
- ESE 302 – SSE
- MATH 312 – SSE, many EE
- CIS 160 – CMPE, EE computing
  - MW9am-10:30am in Fall 2014
    - (unfortunately, conflicts with ESE215)

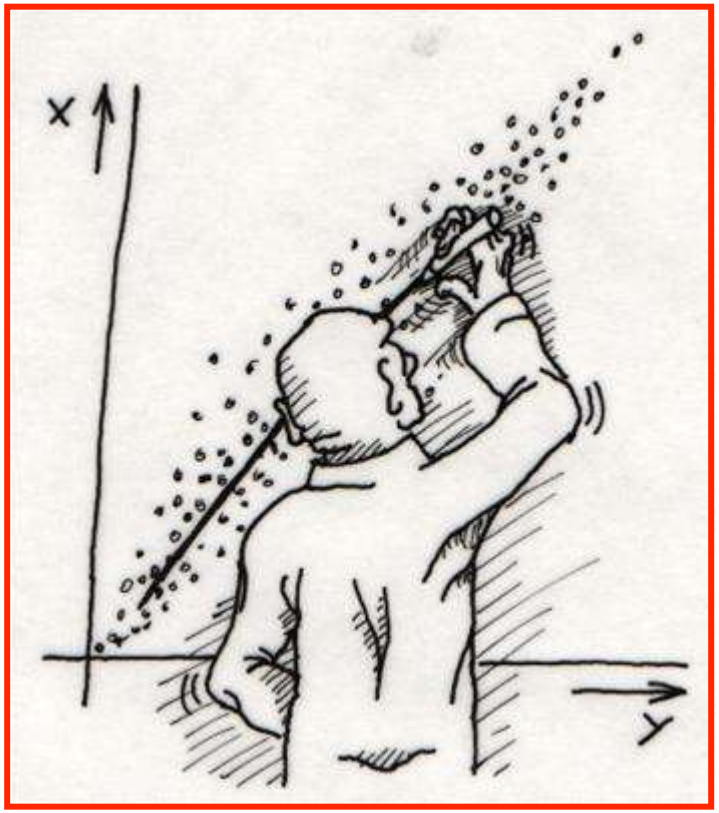
ESE301: Engineering Probability

- Pre-req: Math 114
- Spring 2015 (not offered Fall 2014)
- Basic ideas of probability theory.
  - Combinatorics.
  - Random variables and functions of random variables.
  - Means, moments and generating functions.
  - Order statistics and special distributions.
  - Central limit theorem.
- Essential to analyzing yield, failure, computer performance, coding, behavior of electrons, molecules, and people.

ESE302: Statistics for Engineers

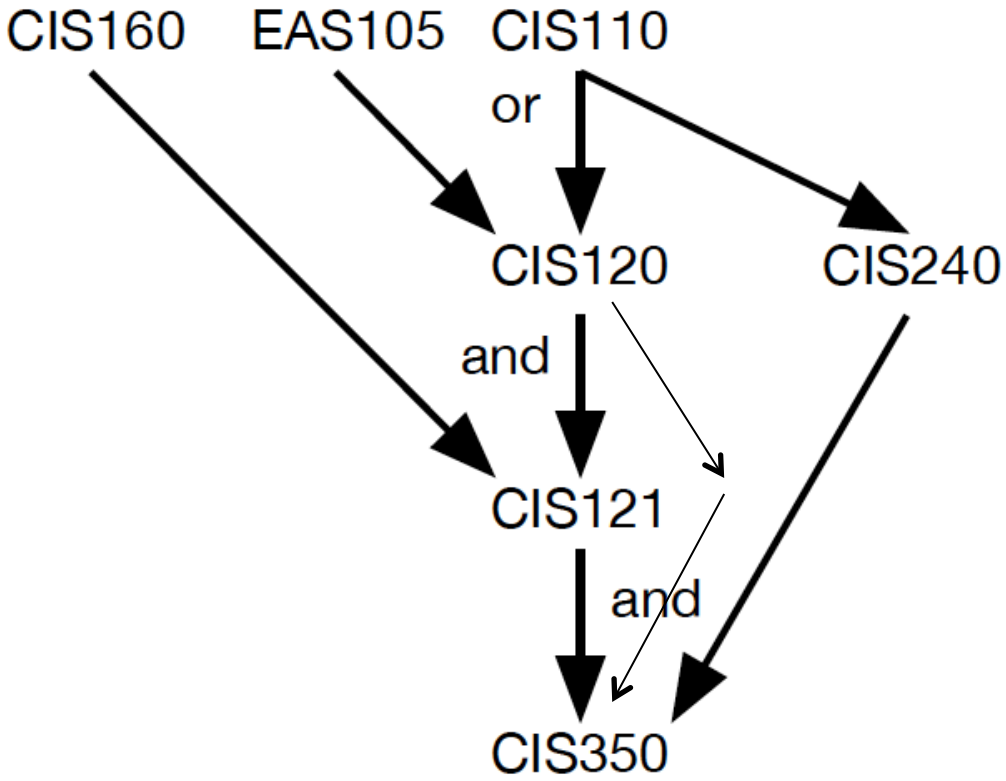
http://www.seas.upenn.edu/~ese302/

- Statistical Estimation
- Confidence Intervals
- Hypothesis Testing
- Multiple Regression



- Pre-req: ESE301
- Spring

Computing Courses



- CMPE take all
- SSE take through CIS120, CIS350 option
- EE take CIS120 or CIS240

CIS 120 (Fall and Spring)

- Fast-paced introduction to programming
- Prerequisite: Some programming experience
  - e.g., a high-school programming course or CIS 110
- Topics:
  - program design, testing
  - lists, trees, recursion
  - abstraction, abstract datatypes: sets, maps, containers
  - heap-structured data, references, aliasing
  - object-oriented design
- Approach:
  - ½ OCaml, ½ Java
  - 8 projects, including: Phylogenetic trees, GUI implementation, Image Processing, Game

CIS 121: DATA STRUCTURES AND INTRODUCTION TO ALGORITHMS IN JAVA

(Fall and Spring)

Prerequisites: 120 and 160!

Themes:

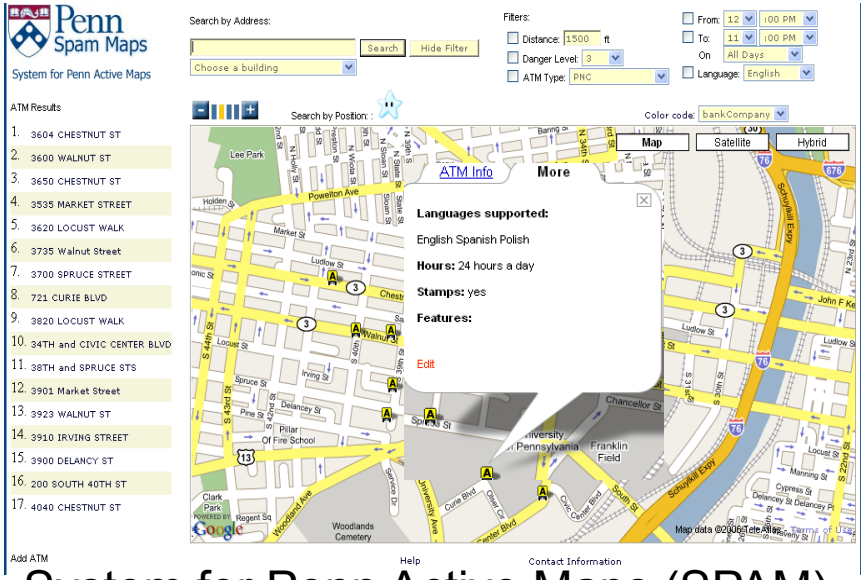
- become an even better programmer
  - 4-5 weekly prog. hwks, 1 multiweek project, Eclipse, JUnit
- worry about efficiency, analyze running time (Big-O)_
  - 2 math-like hwks, math-like questions on exams
- learn the "data structures" set of techniques
  - Stacks, Queues, Lists, Trees, Heaps, Search Trees, Graphs, Hash Tables

Grade: two midterms, final, homework, lab participation

CIS 350: Software Design & Engineering
(Murphy, Spring)

Large-scale software engineering:

- Large versus small systems
- Project Scheduling: Planning vs. Reality
- Internal Communication & Documentation
- Programming in teams/groups
- Planning, Coding and Testing
- Tools – version control, HLL, toolkits
- Design methodologies – "Cathedral" vs. "Bazaar", open source, commercial dev.
- Manuals, User Interfaces (look and feel)



System for Penn Active Maps (SPAM)
http://spam.seas.upenn.edu

Text: F. P. Brooks, Jr. "*The Mythical Man-Month (20th Anniversary Ed.)*"

Grading:

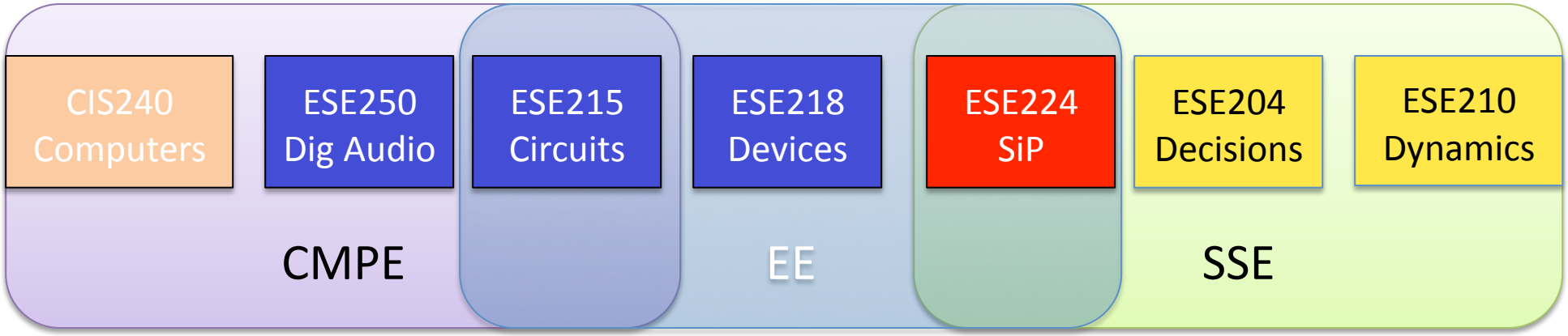
- 20% Project Plan
- 20% Mid-term exam
- 20% Final Exam
- 40% Project Evaluation

1 Lecture/week, 1 All-hands mtg./week

Project (currently Web 2.0 focused):

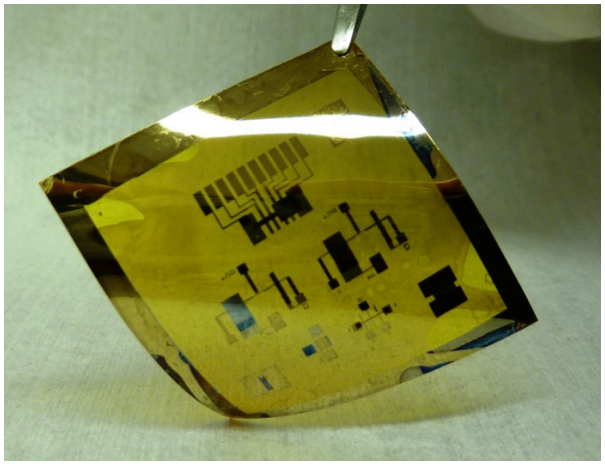
- Run as a software startup
- 2-4 person groups
- System admin and test groups
- Application groups focus on adding new services, such as: ATMs near Penn, Food trucks, Facebook event planner, Career services events, etc.
- Weekly "all-hands" meetings with 5-slide presentations by each group

Where go after Sophomore Courses?

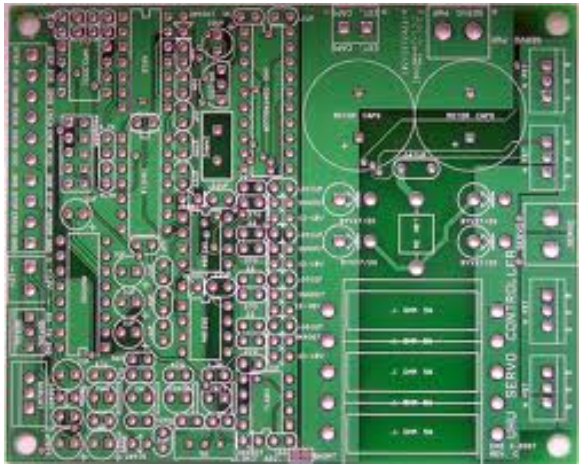


EE Vision & Themes

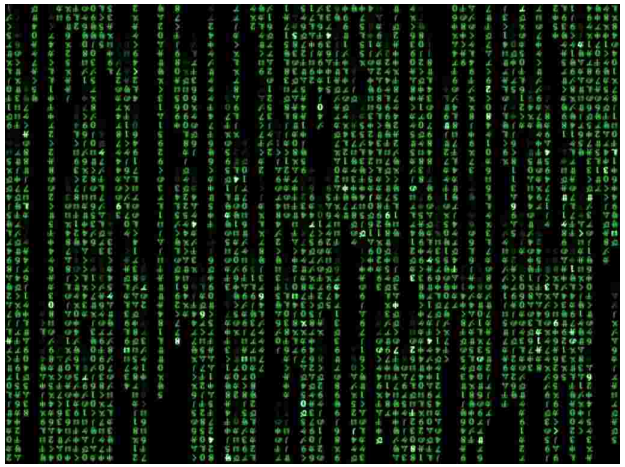
EE connects the physical with the information world



Nanodevices and systems

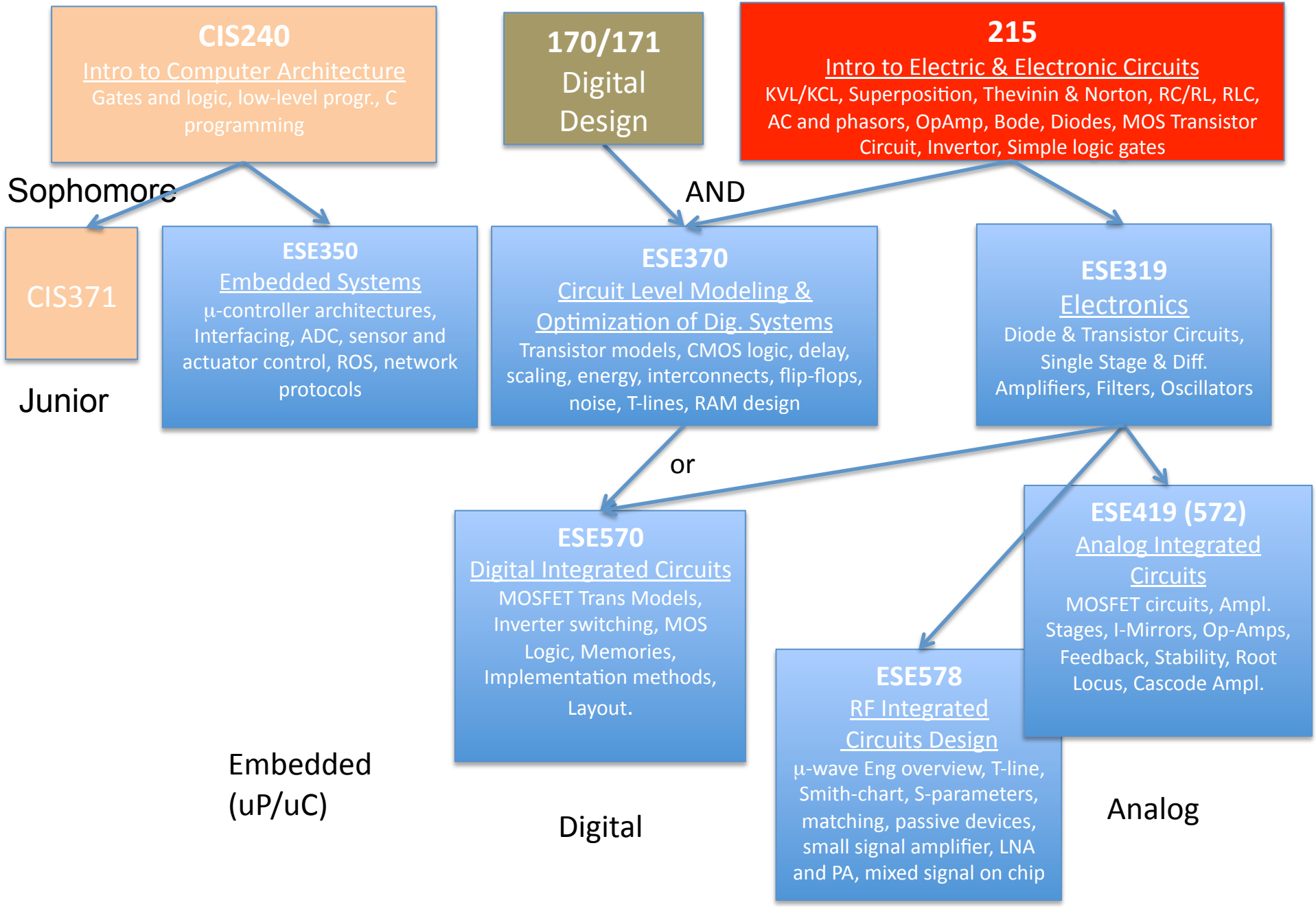


Circuits & Computer Eng



Information & Decision

Circuits and Computer Engineering



Electronics, Photonics, and (Electro) Mechanics

Sophomore

ESE 218
Electronic, Photonic, and Electromechanical Devices

Junior

ESE 321
Physics and Models of Semiconductor Devices
pre-req: 215, 218

ESE 310
Electric and Magnetic Fields 1
pre-req: Phys 151, Math 240

ESE 3xx
Junior lab (advanced lab studies)
Pre/co-req: ESE321 /310 or permission

Senior

ESE 460/574
Semiconductors micro-fabrication
pre-req: ESE321 or permission

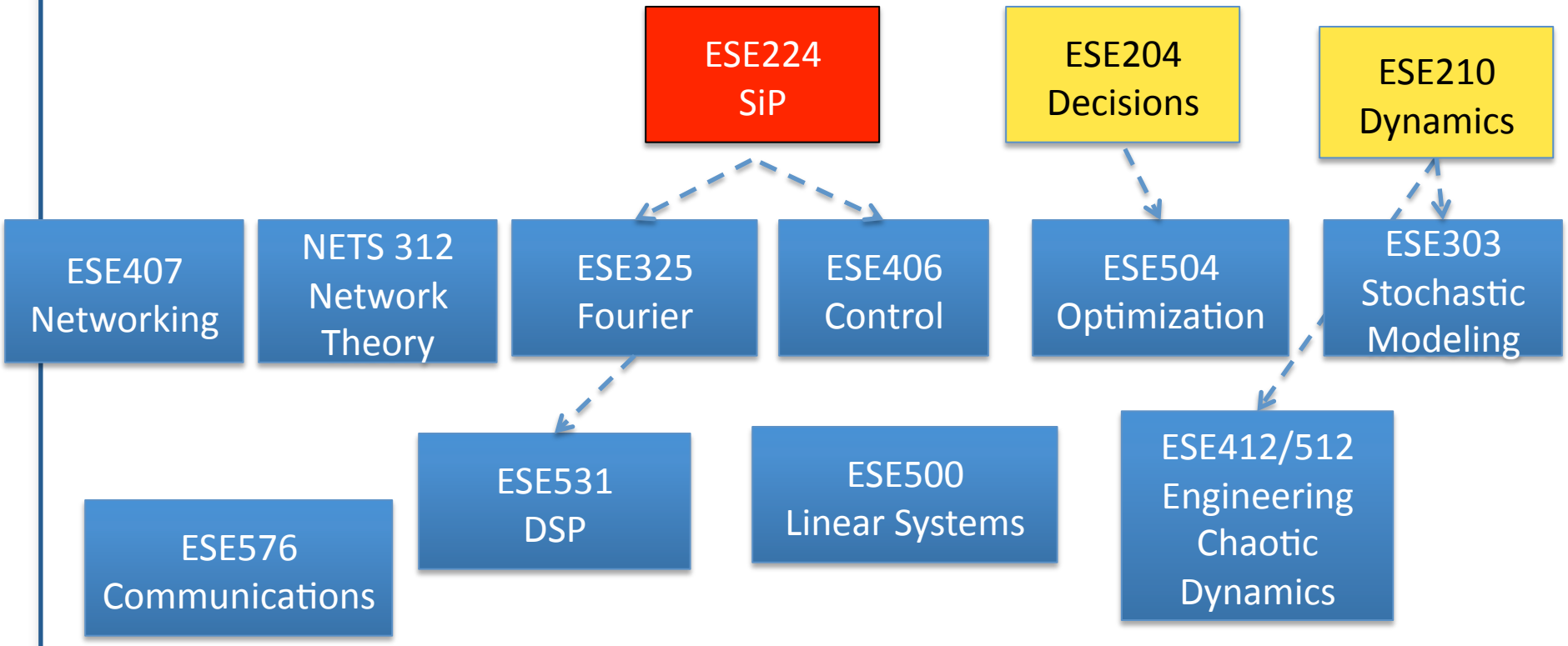
ESE 521
Physics of Solid State Energy Devices
pre-req: ESE 321, Phys 240, MSE 215 or equiv.

ESE 509
Waves, Fibers and Antennas for Communications
pre-req: Math 240, ESE 310

ESE 510
Electromagnetic and Optical Theory
pre-req: Undergrad EM

ESE 525
Nanoscale Science and Engineering
pre-req: ESE 218, Phys 240, MSE 215

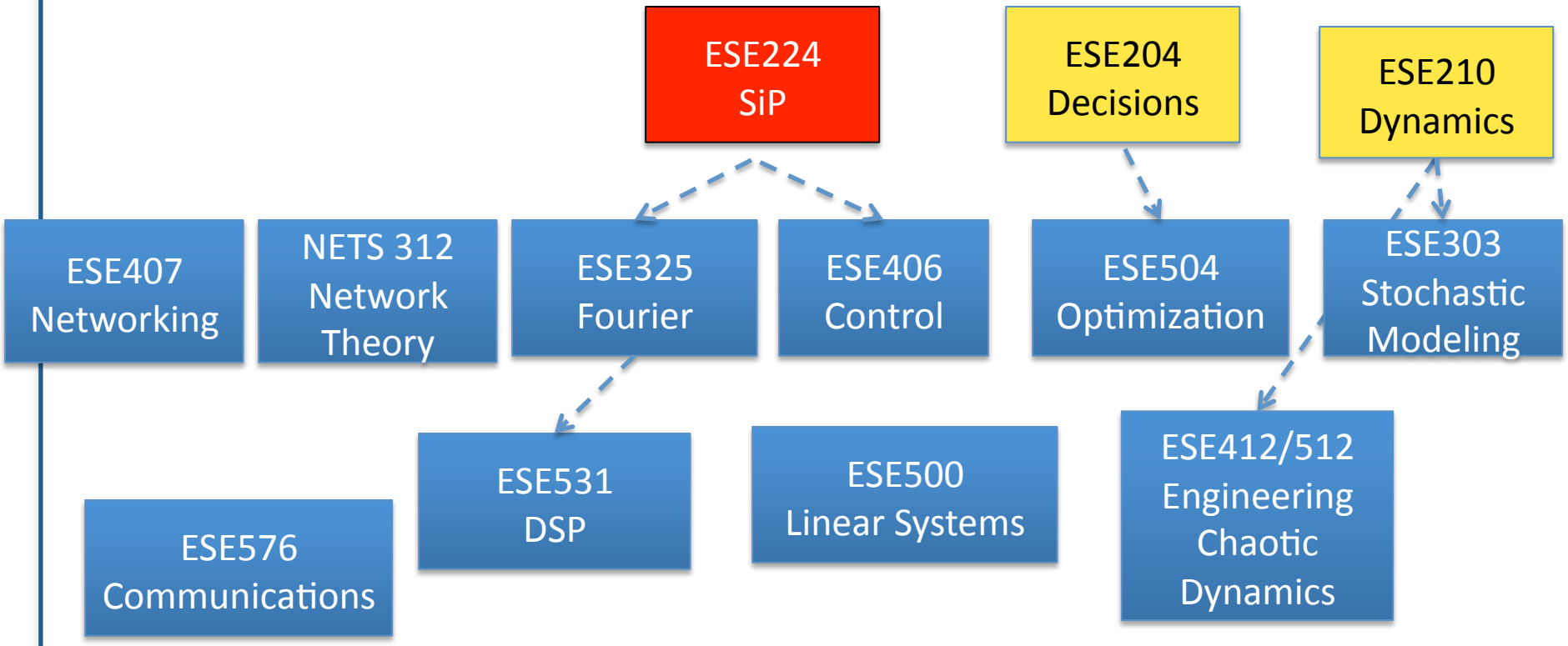
Information and Decision Systems



EE Recommended Courses by Area of Interest

- Devices
  - ESE310, ESE321, ESE3xx-devices-lab, ESE521
- Circuits
  - ESE319, ESE370, ESE350, ESE406, CIS240
- Embedded Systems
  - ESE350, ESE406, CIS120, CIS240, CIS441
- RF Electronics
  - ESE310, ESE319, ESE419, ESE578
- Robotics
  - ESE210, ESE304, ESE406, ESE350, MATH312, CIS240, MEAM101, MEAM410

Information and Decision Systems



ESE303: Stochastic Systems Analysis and Simulation

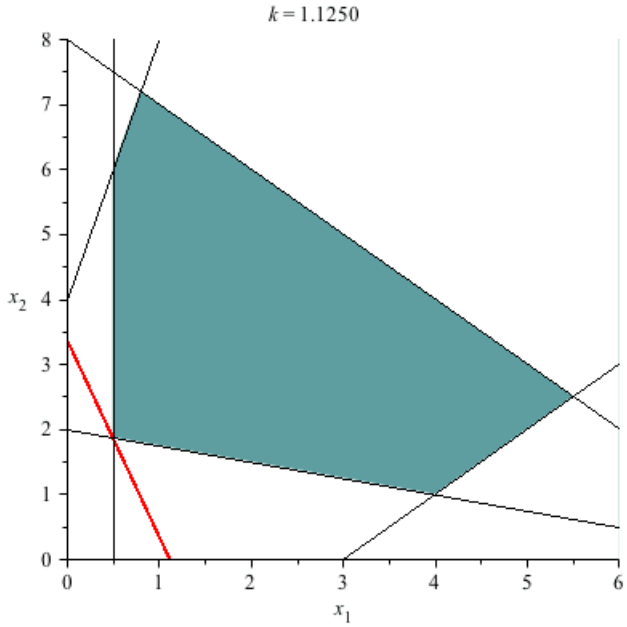
https://alliance.seas.upenn.edu/~ese303/wiki/

- model, analyze and simulate stochastic systems
- “anything random that changes in time”
  - Theoretical -- discover and understand properties of the system
  - Experimental – usually computer simulation (MATLAB)
- Applications in: communication, machine learning, social systems, markets, molecular biology and epidemiology.
- Prereq: ESE301, programming
- 1.0 CU, Fall

ESE304: Optimization Theory

- Theory and Applications of Linear Programming – Simplex Method
- Sensitivity Analysis – Dual Simplex Method
- Theory and Applications of Integer Programming – Branch and Bound Method
- Theory and Applications of Nonlinear Programming – Lagrange Multipliers
- Quadratic Programming Methods
- Prerequisites: MATH 104, 114 and 240
- Fall and Spring

ESE 504



From pricing airline tickets and deciding which passenger should board when, and from organizing paragraphs in LaTex Documents, Linear Programing and its extensions are everywhere

Need a strong background in Linear Algebra

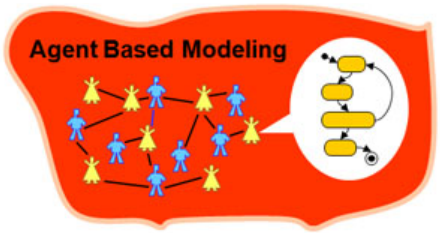
Fall

This course deals with the mathematical theory of optimization. Topics covered include

- Linear programming, Simplex method, duality theory, theorems of alternative
- Examples from Control theory, Signal Processing, Operations Research, Economics, Finance,...
- Network flow problems
- Integer programming and combinatorial optimization
  - Traveling Salesperson Problem,
  - Matching

ESE403: Operations Research In Systems Engineering

- Transportation and Assignment Problems
- Network Flows, Minimum Cost Network Flow Problems – The Network Simplex
- Optimization Methods in Game Theory
- Optimization Methods in Utility Theory
- Finite Regular and Finite Absorbing Markov Chains
- Prerequisites: ESE 304
- Spring



ESE308 Agent-Based Modeling & Simulation

- Model, simulate, and understand systems that are ill-structured and whose mathematics is initially unknown and possibly unknowable
- a toolbox and methodology for attempting to represent and study complex socio-technical systems
- paradigms of the agent based approach
  - eg., “light agents”, finite state machines, game theoretic rational actor theory, socio-cognitive and affective agents
- analyze the robustness and emergence of system equilibria as a function of sensitivity to parameter shifts and policy changes.
- Pre-req: probability, Java or C programming
- 1.0 CU, Fall

NETS 312: Network Theory

- *Instructor*: Victor M. Preciado.
- *Level*: Juniors and Seniors
- *Prereq:* ESE 301 (Intro to Probability), and MATH 312 (Linear Algebra)
- *Description*: Networks are ubiquitous in our modern society, playing an increasingly larger role in every day life. *Network Science and Engineering* is a new discipline that investigates the structure of large complex networks and their behavior and properties, and then designing technologies that control and manipulate their behaviors to bring about greater benefits to society. In this course, students will learn some of the tools, methods, and algorithms for analysis of networked systems, as well as practical applications of this new science.
- *Topics to be covered*:
  - Concepts in network theory
  - Discuss metrics and models for large-scale networks
  - Use software analysis tools to experiment with real-world network data
  - Study applications in several areas
- Spring

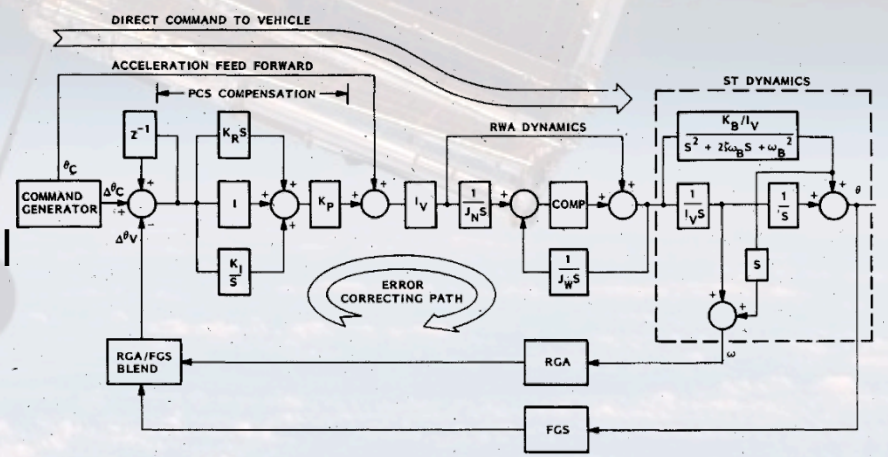
ESE 325 Fourier Analysis and Applications

- 1CU Fall
- Prereq: MA240
- the Fourier series and transform spectrasystems of differential equations
- superposition,memory, and non-linearity
- resonance,eigenfunctions;
- mean-square approximation
- interpolation and prediction, sampling
- random processes, stationarity
- wavelets, Brownian motion
- stability and control, Laplace transforms

ESE 406 : Control of Systems

Spring Semester Annually – Dr. Bruce D. Kothmann

- Pre-Requisite
  - Sophomore-Level Math : Ordinary Differential Equations
  - Freshman-Level Physics : Mechanics & Electrical Circuits
- Topics Covered:
  - Mathematical Models of Dynamic Systems
  - Feedback Effects on Modal Frequency & Damping (Root Locus)
  - Feedback Effects on Bandwidth & Stability Robustness (Bode Plots)
  - Introduction to Modern Control Methods
- Typical Applications
  - Automobile Cruise Control
  - Aircraft Autopilot
  - Greenhouse Temperature Control
  - Space Telescope Pointing
  - Robotics
  - Senior Projects & Mechatronics
- Lab Projects



http://www.youtube.com/watch?v=WKzwpj2QTKI

ESE 407 / 507:
Introduction to Networks and Protocols

Fall 2014

- Emphasis on basic systems-level concepts and analysis; *not* programming based
- Store-and-forward packet switching; reliability, error control
- Local area networks (Ethernet, Wi-Fi)
- Internet Protocol (IP), TCP; Routing, Congestion Control
- Basic Queuing Analysis
- Network Security

- Pre-requisite: Probability Theory (ESE 301 or equivalent)
- Fall

CIS 553: Networked Systems
(Fall)

- Course website: http://www.cis.upenn.edu/~boonloo/cis553-fa07/
- How are networks designed, tested, and built? How do routers work? How can we build overlay networks over the Internet?
- Topics covered: Internet architecture, routers, transport protocols (TCP), network security, p2p networks, wireless networks, overlay networks, network testbeds (PlanetLab), network simulation/simulation tools
- Course pre-requisites: CSE 121 or equivalent.
- Students design and build a large networked system, layer-by-layer on a 24-node cluster:
  - Router implementation: Link state and Distance Vector protocols
  - Chord Distributed Hash Table over their routing code
  - P2P applications (e.g. keyword search, publish/subscribe) over Chord

CIS 553 Projects

- Undergraduates are welcomed!
  - 7 undergrads last year, out of 34 students. All did very well.
  - 3 Penn undergrads and 2 masters students working on independent studies with Prof. Loo 2012
    - One has submitted an ACM SIGCOMM workshop paper!
    - Another is doing summer internship at a startup company collaborating with Prof. Loo.
- 2013:
  - TCP: students build a reliable transport protocol over their routing protocol implementation
  - Network Simulator (NS-3) open-source development
    - http://www.nsnam.org/

ESE500: Linear Systems Theory

- Linear Systems of Differential Equations and Difference Equations
- Time Variant, Time Invariant and Periodic Systems, Functions of Square Matrices
- Internal and External Stability Analysis
- Controllability, Observability, Realizability
- Linear Feedback Contol
- Prerequisites: MATH 240 and MATH 241
- Fall

ESE 531: Introduction to Digital Signal Processing

Fall

- Essential Pre-requisite: Signals and Systems (ESE 325)
  - Basic knowledge of Matlab also assumed
- Of interest to motivated seniors, first-year graduate students

- Course covers fundamentals of discrete-time signals and systems, and digital filtering.
- Topics include Z-transforms; discrete-time Fourier transform (DTFT) and FFT; sampling and rate conversion; digital filter structures, analysis, and design; adaptive filters; filter banks.
- Course provides *fundamental* understanding through analysis of discrete-time systems.

ESE 576:
Digital Communications

Spring

- Essential Pre-requisites:
  Signals and Systems (ESE 325), Probability (ESE 301);
  (basic knowledge of random processes and analog communications also assumed.)
- Of interest to motivated seniors, first-year graduate students

- Provides *fundamental* understanding through mathematical analysis of concepts and systems

- Topics include: Basics of information theory, source coding, and capacity; bandwidth, intersymbol interference, and equalization; orthogonal signaling; digital modulation; block and convolutional codes

Electronics, Photonics, and (Electro) Mechanics

Sophomore

ESE 218
Electronic, Photonic, and Electromechanical Devices

Junior

ESE 321
Physics and Models of Semiconductor Devices
pre-req: 215, 218

ESE 310
Electric and Magnetic Fields 1
pre-req: Phys 151, Math 240

ESE 3xx
Junior lab (advanced lab studies)
Pre/co-req: ESE321 /310 or permission

Senior

ESE 460/574
Semiconductors micro-fabrication
pre-req: ESE321 or permission

ESE 521
Physics of Solid State Energy Devices
pre-req: ESE 321, Phys 240, MSE 215 or equiv.

ESE 509
Waves, Fibers and Antennas for Communications
pre-req: Math 240, ESE 310

ESE 510
Electromagnetic and Optical Theory
pre-req: Undergrad EM

ESE 525
Nanoscale Science and Engineering
pre-req: ESE 218, Phys 240, MSE 215

ESE310: Electric and Magnetic Fields I

http://www.seas.upenn.edu/~ese310/

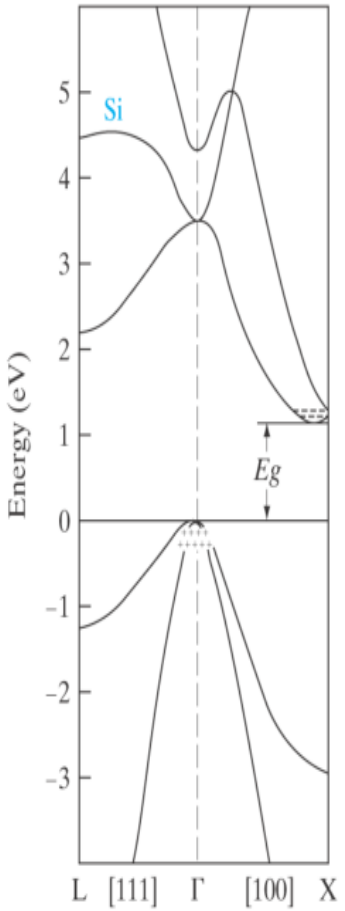
- Electromagnetism, Electrostatics, Magnetostatics.
- Coulomb's Law, Gauss' Law, Biot-Savart Law, Ampere's Law, Faraday's Law
- Maxwell's Equations,
- Time-Varying Fields, Wave Equation, Wave Propagation
- Pre-req: PHYS 151, MATH 240
- Spring

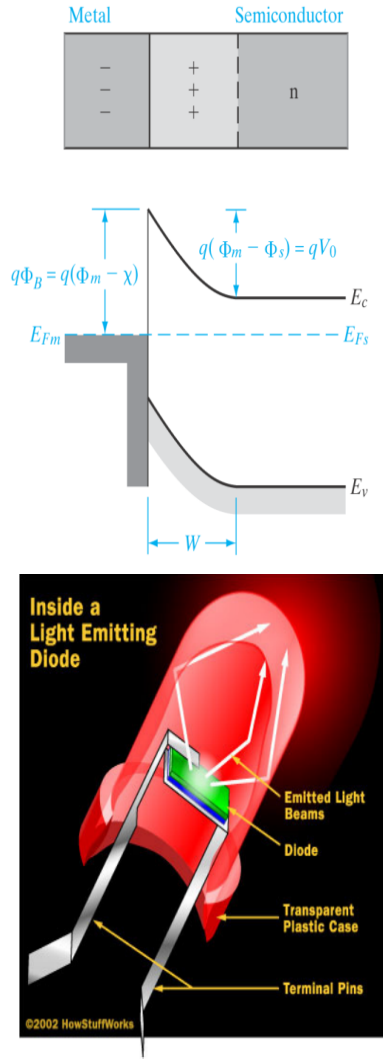
New Course

ESE 321

Physics and Models of Semiconductor Devices

- Introduction to fundamentals of semiconductor technology:
  - Fundamentals – quantum mechanics, band theory, carrier dynamics and doping
  - Technology – diodes, transistors, integrated circuits, optoelectronics
- Core background for further study in applied physics, nanotechnology, VLSI design, and computer engineering
- Pre-req: ESE 215, ESE218
- Fall, 1CU





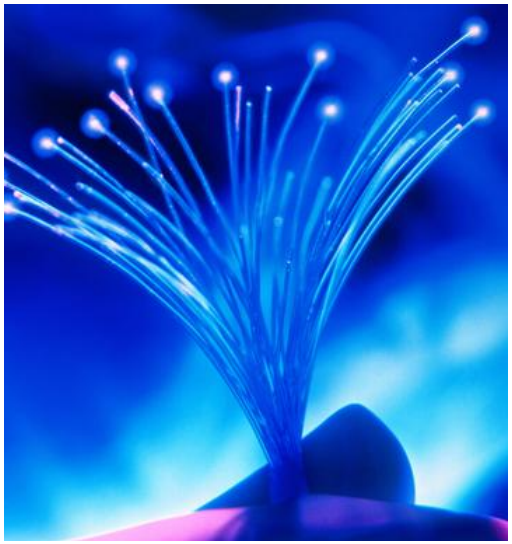
ESE 460/574

Semiconductors micro-fabrication

- A senior / first year graduate student course on the fundamental principles of (mostly) silicon micro-fabrication.
- laboratory component offered during the last six weeks of the semester.
- Topics: purification and growth of Si single crystals, photo-lithography, doping and diffusion, ion-implantation, chemical vapor deposition and vapor phase epitaxy. Physical vapor deposition, sputtering and e-beam evaporation. Wet etching and plasma processing. Packaging issues are discussed if times permit.
- ESE 218 or instructor permission is a Pre-requisite,
- An excellent course for those engaged or planning to engage experimental work involving micro-fabrication and MEMS devices.
- Fall, 1 CU

ESE 509: Waves, Fibers and Antennas for Communications

- Goals:
  - Understand the fundamental optical and wave processes used in the physical layer
  - Understand the operation and design of optical components and systems used in communications
  - Analyze simple antennas and design li arrays for communications
- Prerequisites:
  - Junior/Senior or graduate standing
  - Math 240 or ESE 310 recommended
  - Fall



ESE510: Electromagnetic and Optical Theory 1

http://www.seas.upenn.edu/~ese510/

- Maxwell's Equations, various EM Laws
- Wave Propagation, Plane Waves, Material Media, Reflection, Refraction
- Scalar and Vector Potentials,
- Antenna, Radiation, Scattering
- Waveguides
- Pre-req: At least one semester of undergraduate electromagnetics
- Fall

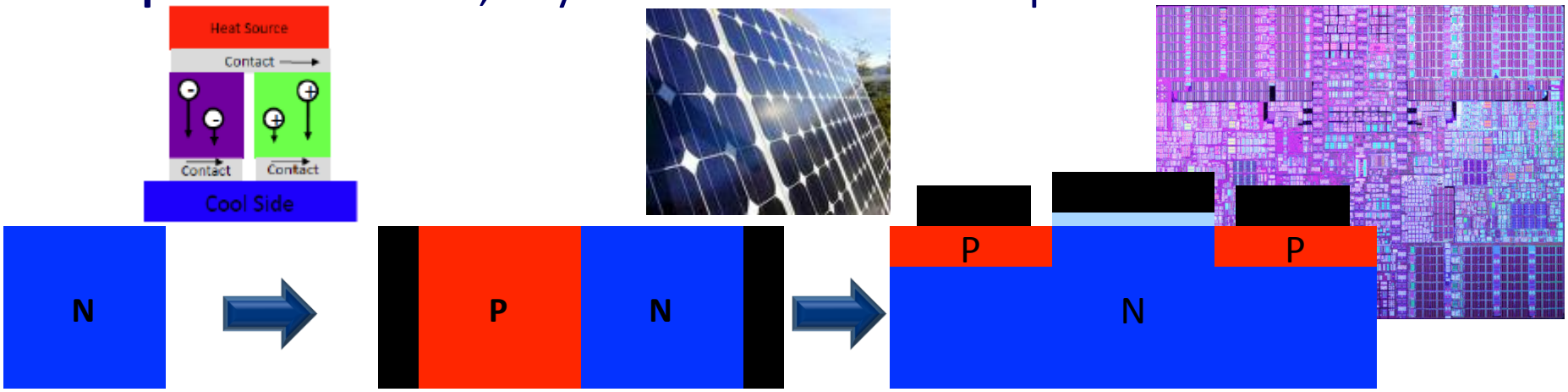
ESE 521: The Physics of Solid State Energy Devices

Description: Physics of traditional and novel semiconductor devices, such as pn junctions and transistors, are important in photovoltaics, thermoelectrics, and low-power, high performance transistors

Credit: 1 CU

Offered: Spring 2014

Prerequisites: ESE 218, Phys 240 or MSE 215 or equivalent



ESE/MSE 525: Nanoscale Science and Engineering

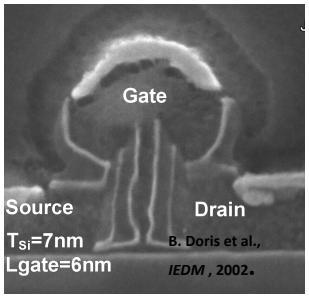
Description: Nanoscale materials and device synthesis, fabrication and characterization of optical, electronic, magnetic, and biological devices for next generation computing, energy, medical, and display technologies

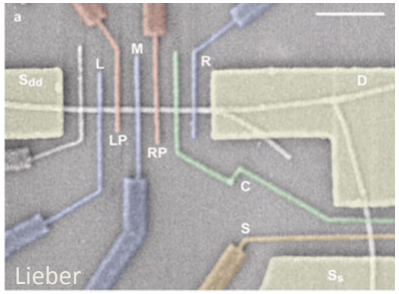
Credit: 1 CU

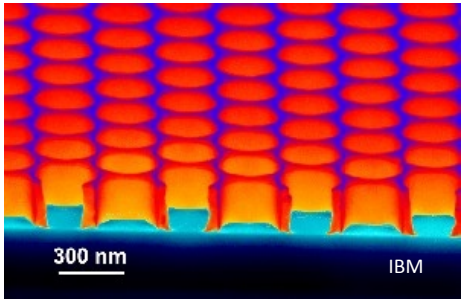
New Instructor: Allen

Offered: Fall 2014

Prerequisites: ESE 218, Phys 240 or MSE 215 or equivalent

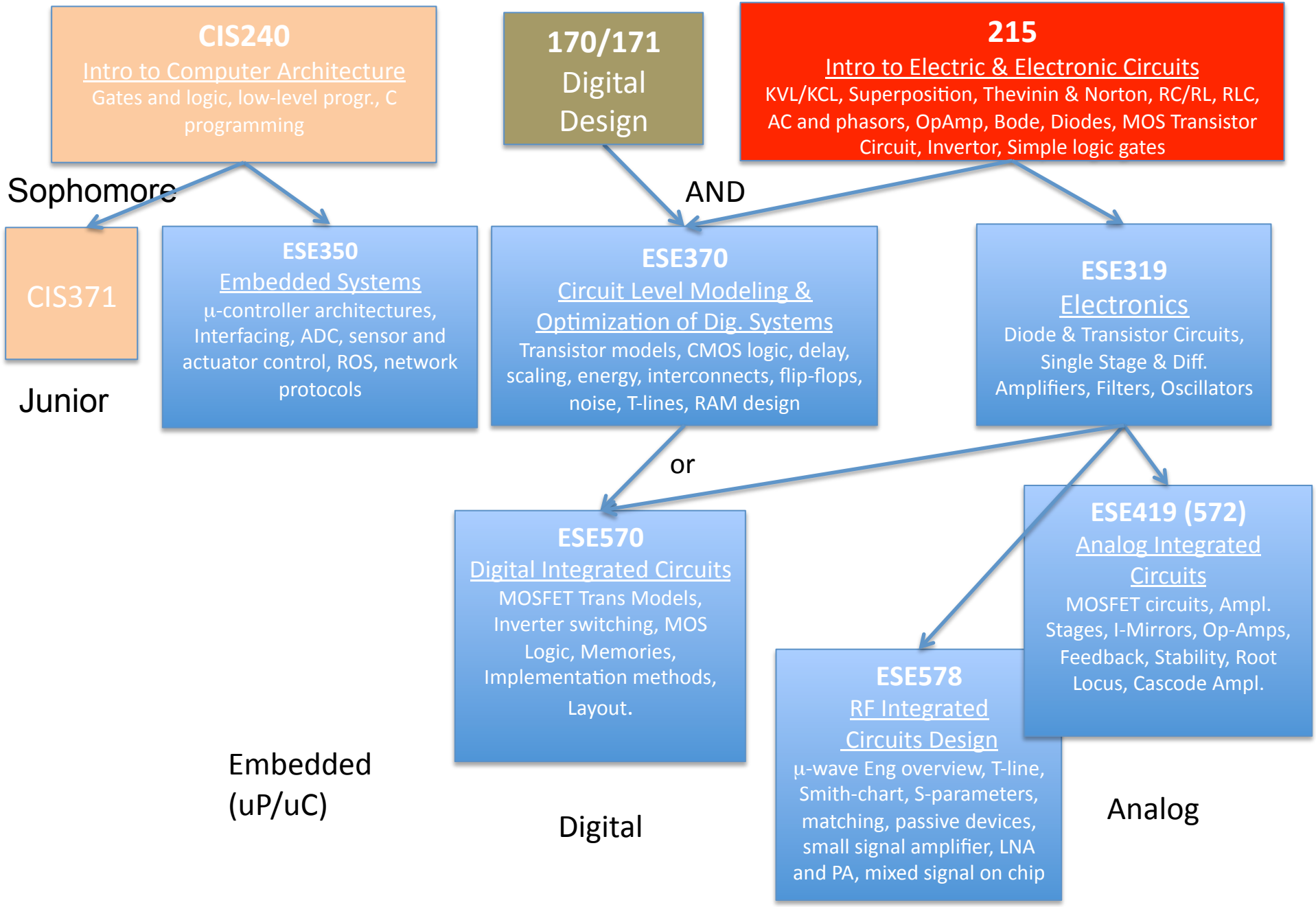






Novel Physical Properties are Harnessed in Devices at the Nanoscale

Circuits and Computer Engineering



ESE319: Fundamentals of Solid-State Circuits

http://www.seas.upenn.edu/~ese319/

- Apply principles of component-insensitive circuit-level design to analog bipolar junction transistor (BJT) circuits.
- Design of stable feedback amplifier circuits that achieve specified gain and phase margins.
- Design of Class A, B, and AB power amplifiers and output stages
- In-the-lab: design, simulate, construct and test of analog circuits to application relevant specs.
- Prerequisite: ESE 216 for 2014 Fall

ESE370: Circuits for Digital Systems

http://www.seas.upenn.edu/~ese370/

- Circuit-level design of gates, storage, and interconnect.
- Physical aspects of energy, delay, area, and noise
- Impact on design and achievable performance.
- Pre-req: ESE170, ESE215
- Fall

ESE570: Digital Integrated Circuits and VLSI Fundamentals

http://www.seas.upenn.edu/~ese570/

- Design of digital VLSI circuits and systems, that are suitable for CMOS fabrication and manufacture.
- Apply the models for VLSI components, hierarchical design flow and semiconductor business economics to judge the manufacturability of a design.
- Apply the Cadence VLSI CAD tool suite layout digital circuits for CMOS fabrication and verify circuits with realistic layout parasitic elements.

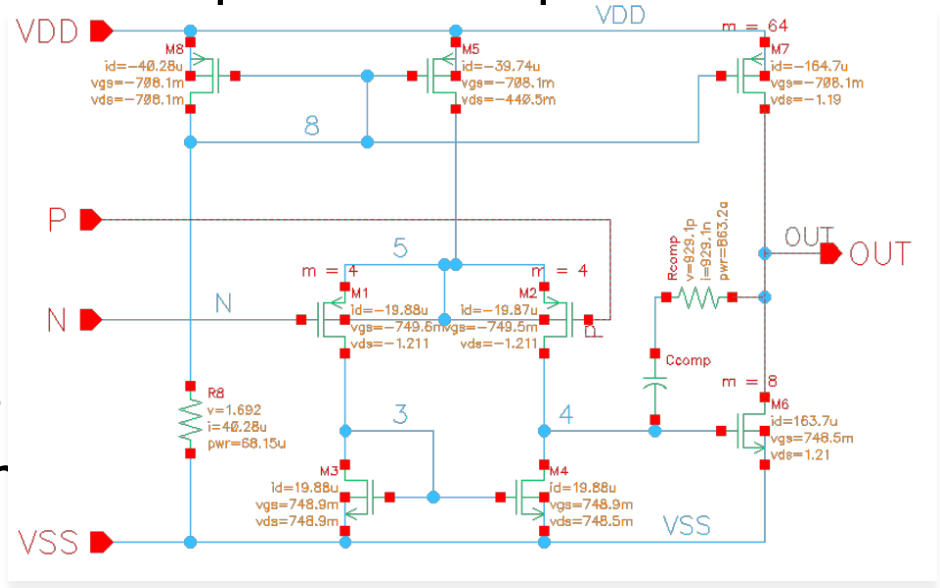
- Prerequisite: ESE319 or ESE370 or equivalent.
- Spring

ESE572/419: Analog IC Design

New Instructor:
Asst. Prof. Firooz Aflatouni

New time: MW3-4:30pm

- Learn basics of analog IC design
  - review of MOSFET and BJT devices
  - current mirrors and differential pairs
  - voltage/current references, bandgap references
  - operational amplifiers, trans-impedance amplifiers
- Feedback in circuits
  - stability of amplifiers
  - oscillators
- Use Cadence for some homework and the term project

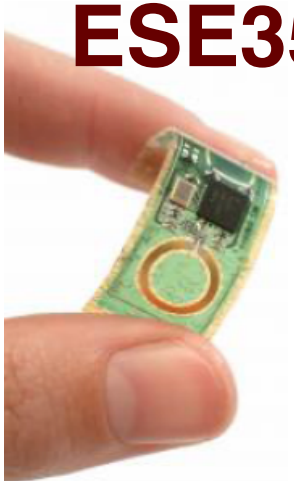


- Prerequisite: ESE319 for ESE419, equivalent course/ background for ESE572

Project and Design Courses

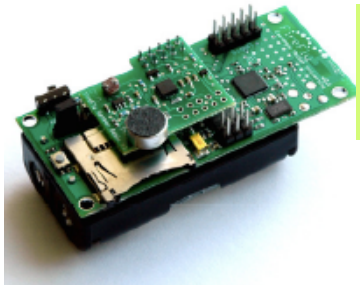
- Encourage Everyone to take at least one junior-level lab (before senior design)
  - ESE350
  - Plan to create
    - Devices-lab
    - Systems-oriented Lab
  - MEAM 410, BE 470
  - CIS 541, CIS 555, CIS 565

ESE350 Introduction to Embedded Systems

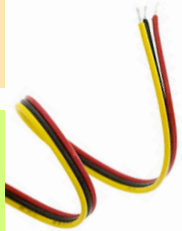


Ever wanted to build some a flying quadrotor, an arcade game or learn how to network wireless sensors, controllers and actuators?

ESE350 is **where hardware marries software** and you learn to program microcontrollers, embedded microprocessors to interface with the physical world.



A great course for CIS/CIT sophomores and juniors. No hardware skills necessary just knowledge of basic C programming



Offered every Spring.
Check out http://www.seas.upenn.edu/~ese350/

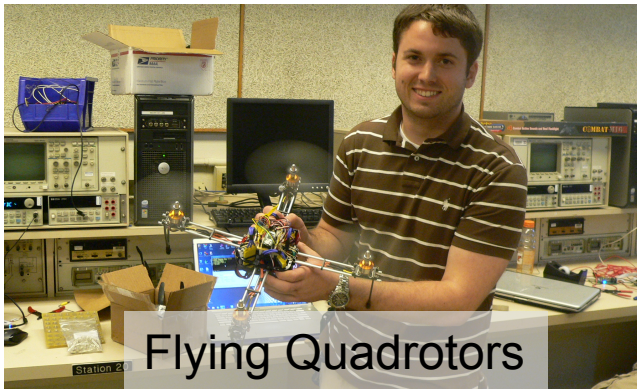
Spring 2015

Pre-requsites: Basic programming in C and circuits. CIS240 is a plus.

The Internet of Things – when sensors, controllers and actuators talk to each other

NBA Arcade Games

Nintendo Hacking



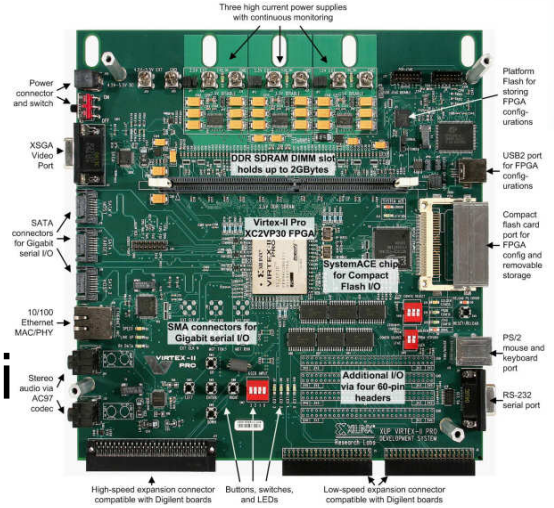
Flying Quadrotors

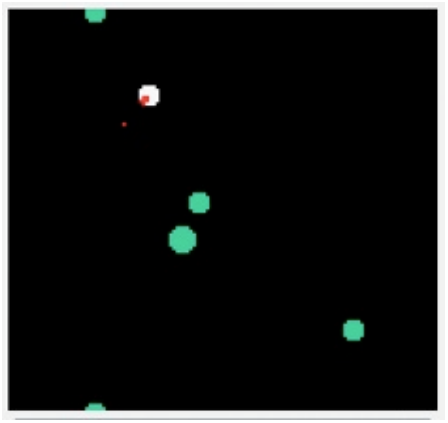
CIS441/CIS541: Embedded Software for Life-Critical Applications (Fall)

- Prerequisite: CIS240; ESE350 recommended
- The course is
  - The course is to study principles, methods, and techniques for building *Cyber-Physical Systems* that are safety critical.
- The goal is
  - to give students greater design and implementation experience in life-critical embedded software development, and
  - to teach them how to model, design, optimize, verify, implement, and validate safety critical systems in a principled manner.
- Topics covered include
  - Cyber physical systems, distributed real-time systems, real-time programming, assurance cases, modeling and verification, testing and validation, software architecture…
- The team project is to design and implement a life-critical system such as a pacemaker, and consists of six tasks:
  1. modeling
  2. verification
  3. implementation
  4. validation
  5. demo
  6. a written report based on assurance case.

CIS371: Computer Organization and Design
(Spring)

- Prerequisite: CIS240
- How hardware "really" works
  - Basic hardware tricks: caching, pipeli speculation, parallelism
  - Performance, costs, and trade-offs
  - Experimental analysis
- Hardware prototyping project
  - Pipelined CPU using Verilog, FPGA
  - Ties in neatly with CIS240





CIS 455 – Internet and Web Systems

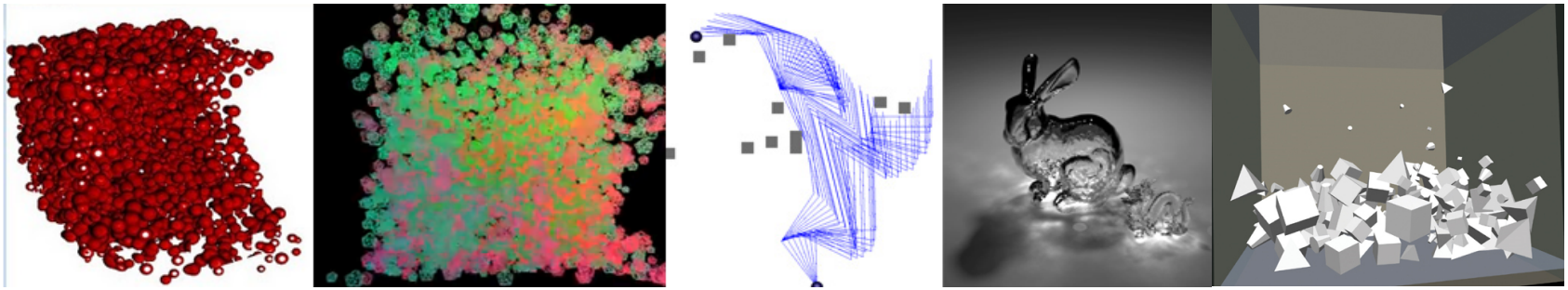
(Haeberlen, Spring)

- How do the systems of the Internet and the Web work – and how do they scale to millions of users?
- How do we build reliable, high-performance systems like EBAY, Google, Facebook, 2nd Life, …?
- How do we exchange and search for data in a distributed Web setting?
- How do we program large-scale distributed applications?

Prerequisites:

- Java skills, debugging skills, some familiarity with threads
- CIS 121 & CIS 380

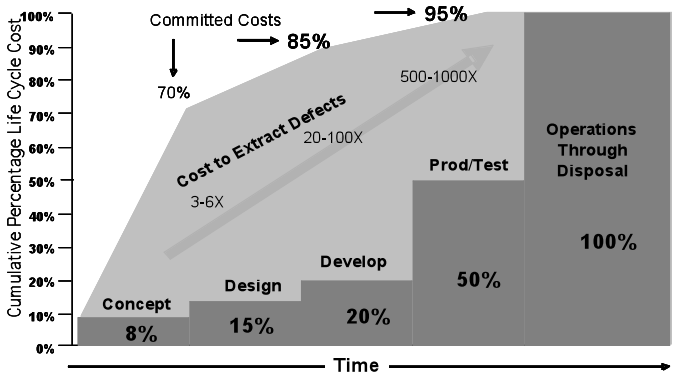
CIS 565: GPU Programming and Architecture (Cozzi, Fall)



1. Understanding of the GPU as a graphics pipeline
2. Understanding of the GPU as a high performance massively parallel multi-core compute device
3. Understanding of various GPU architectures
4. Programming in: CG, CUDA and *OpenCL*
5. Exposure to many core graphics effects performed on GPUs
6. Exposure to many core parallel algorithms performed on GPUs that enable dramatic increases in computing performance

ESE590 Systems Methodology

- Systems theory, methodology, and modeling
- Methodologies and techniques important to DESIGNING large complex, purposeful systems and to discovering policies that influence them throughout the stages of their lifecycle
- Synthetic thinking…assemble the big picture from modeling the individual actors, organizations, and artifacts in a socio-technical system of interest
- Emergence of macro-behavior from the micro-decision making of the actors involved
- Pre-req:
- 1.0 CU, Spring



Technology Management

- Encouraging students to take
- EAS545 – Engineering Entrepreneurship
- ESE400 – Engineering Economics
- EAS595 -- Leadership

ESE400/540 Engineering Economics

- Systematic framework for evaluating the competitive economics of alternative design or project solutions.
  - cost-driven design economics, break-even analysis, money-time relationships and equivalent worth, rates of return, cost estimation, pricing strategy, depreciation and taxes, inflation, foreign currency exchange rates, life cycle analysis, benefit/cost ratio analysis, replacement analysis, dealing with uncertainty, probabilistic risk analysis, capital financing and cost of capital, and financial statement analysis
- Case studies applied to real-world problems.
- Pre-req: Knowledge of differential calculus
- 1.0 CU --Offered every Fall and Spring term

EAS 595: Foundations of Leadership

- Goal:
  - Enhance your leadership capacity and the leadership capacity of those around you
- Topics:
  - Leadership in Groups & Teams
  - Leadership and the Individual
  - Leadership Strategy
  - Leadership Across Cultures
- Methods of Learning:
  - Experiential learning (classroom experiments)
  - Self-assessments
  - Case studies
  - Video and film
  - Key papers from the literature

New Course

Spring 2015

ESE 418

Energy Storage Devices

- A junior / senior level course in the fundamental aspects of electrochemical cells, batteries and super-capacitors.
- fundamental principles of electrochemistry as utilized by electrical engineers in the design, construction and utilization of high energy density and power density devices.
- development of electrochemical cells from alkali based electrodes with inorganic electrolytes to carbon / lithium based electrodes with organic electrolytes, and the development of super-capacitors from electrical double layer to Faradaic pseudo-capacitors.
- An excellent course for those interested in electrical energy generation, storage and utilization
- 1CU, Offered every two years in the fall semester

Lead-acid batteries: Pb/H 2 SO4 / PbO2

Voltage: 2 V too heavy ; low energy density, ~40 Wh / kg.

ESE444/544 Project Management

- Connecting the art and science of project management
- Planning, organizing, motivating and controlling resources to achieve project goals
- The course covers the Project Management Body of Knowledge (PMBOK)
- Reflections on the role of systems thinking and design thinking to project management
- Pre requisite ESE400
- Spring and Fall

EAS 203: Engineering Ethics

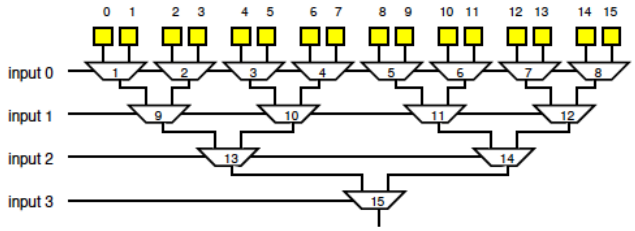
- major ethical issues associated with engineering practice
- practical technical writing skills
- historical case studies
  - Challenger disaster, the Bhopal gas leak, and the Deepwater Horizon oil spill
- causes and consequences of—and remedies for—technological failure
- 1CU, Fall and Spring

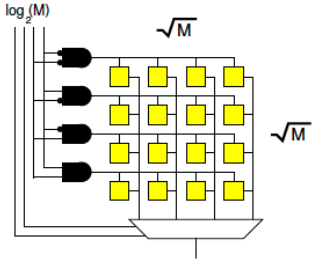
CIS-125: Technology and Public Policy
(Fall)

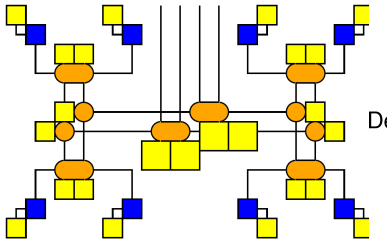
- How does technology affect our society? What's the right way to deal with disruptive advances in technology? Can engineers be more powerful than politicians?
- We look at different technologies each week
  - Policy issues examined from engineering perspective
  - Engineering issues examined from policy perspective
- Non-engineers welcome
- Substantial writing and discussion

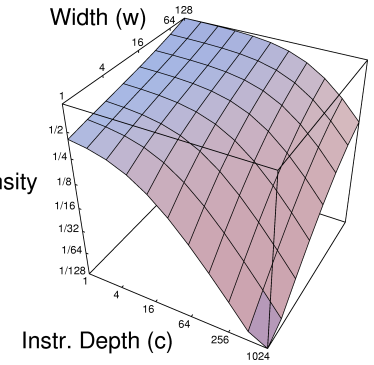
ESE534

http://www.seas.upenn.edu/~ese534/

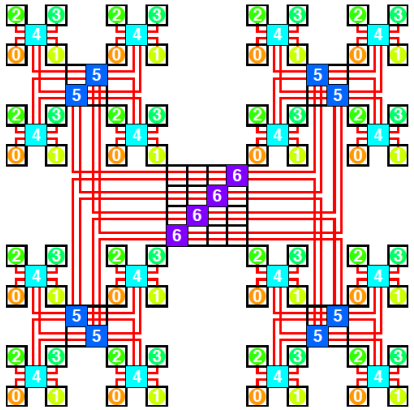






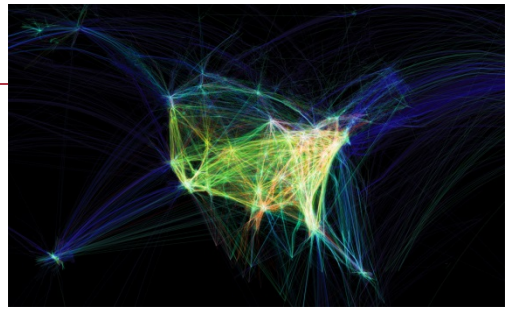


- Design of physical computing systems
  - Design space includes FPGAs and Processors
- How organize memories, ALUs, interconnect into programmable machines?
- **Goal**: Teach you to think critically and independently about computer design.
- Spring 2014 (not offered 2015)
- Prereq: ESE170 or CIS371



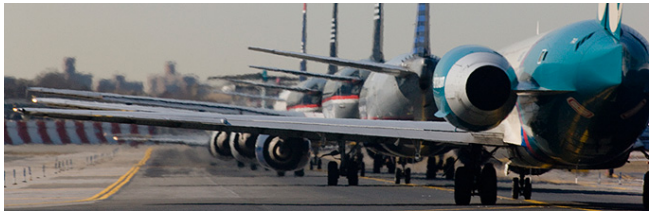
NEW

City and Regional Planning CPLN 750
Advanced Transportation Seminar: Air Transportation Systems



Seminar course on air transportation that will involve lectures, readings, discussion, case studies, and a group or individual research project.

Course will introduce and utilize methods across fields including economics and behavioral modeling, operations research and network modeling, statistics, environmental planning, and human factors



Topics include:

- **intercity multi-modal planning including High Speed Rail**
- **airport environmental issues and the planning environmental planning process**
- **network design and reliability**
- **air traffic management optimization and recovery from extreme events**
- **airline operations, economics, and fuel**
- **land use issues and multiple airport systems**

This course is open to upper-level ESE undergraduates and graduate students

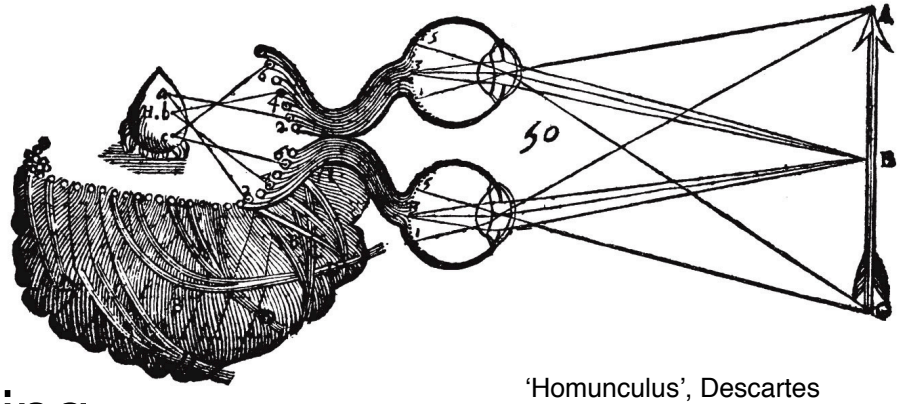
Spring 2014: Tuesday 9--noon

PennDesign

PSYC 111 - Perception

fall 2013

http://www.sas.upenn.edu/~astocker/lab/teaching.php



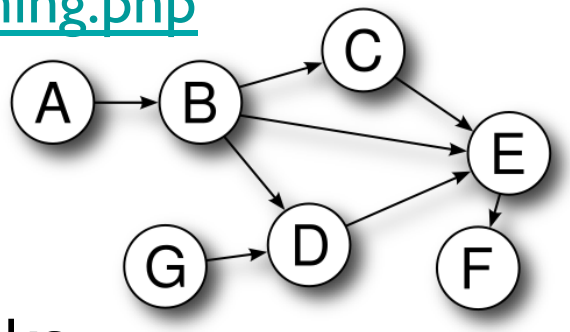
'Homunculus', Descartes 1664

- Vision, Audition, Proprioception, Chemical Senses
- Neural sensory processing
- Attention and Adaptation
- Psychophysical methods
- Computational models of Perception
- Origins of perceptual illusions

PSYC 739 - Probabilistic models of Perception and Cognition

spring 2014

http://www.sas.upenn.edu/~astocker/lab/teaching.php



- Probability theory
- Modeling perceptual decision tasks
- Graph theory, generative models
- Learning and temporal models
- Neural emulations of probabilistic inference

CIS 331:
Intro to Networks and Security

- Nadia Heninger
- http://www.cis.upenn.edu/~nadiah/

- Spring 2015

Piazza Groups

- CMPE101, SSE101, EE101
  - piazza.com/upenn/spring2013/cmpe101
  - piazza.com/upenn/spring2014/sse101
  - piazza.com/upenn/spring2014/ee101
- Use like course Piazza groups
  - Ask questions (find answers) about CPGs, requirements, course sequences, ….