EECS 215 INTRODUCTION

© Fred Terry

Fall Semester, 2013

Outline

- Conduct
- Important Dates
- Grading
- Late Policies
- Keys to Success in 215
- Labs
- Introductory Comments
- Electrical and Computer Engineers: What Do They Do?

Conduct

- I and the rest of the teaching staff are here to help you learn this material and to prepare to use in later classes and in you professional career
- Be Professional and Courteous
  - I'm ultimately in control of the classroom. You may interrupt my lectures with questions but I may have to limit lecture time discussions
  - I will try to treat you with respect and demand the same in return from you for both me and the rest of the teaching staff
- Basic Rule: Don't do anything that interferes with your fellow students' ability to get the most out of the class
  - If your behavior is disruptive to the class, I will demand that you either stop or leave
  - No cellphones
    - Turn them off or put on vibrate
    - No talking, texting, etc.
    - If you have an urgent situation, quietly leave the room
  - Computer use is discouraged
    - If you must use it for notes, take great care to not disturb the rest of the class. Mute the speakers, etc.
    - No game playing, web surfing, etc.

Important Dates

- Last Day to Add and to Drop a class without a "W", Monday, September 23rd, 2013
- **Exam 1: Monday, Oct. 7, 6:00-8:00 PM**
  - **Alternate time for those in Math 216: 3-5pm**
- Last Day to Drop without a Petition (*very* hard) Friday, Nov. 8, 2013
- **Exam 2: Monday, Nov. 18, 6:00-8:00 PM**
- **Final Exam, Tuesday, Dec. 17, 7:00-9:00 PM**

Grading I

Labs	20%
Problem Sets	15%
Quizzes & In-Class	5%
Midterm Exams 1	15%
Midterm Exam 2	20%
Final Exam	25%

Grading II

- FA12 Grade Scale
  - Approximate "Worst case" Scale
- We reserve the right to "curve" the grades upward if we see fit (i.e. exams turn out to be harder than intended). We will not curve the grades down.
- There will be no pre-set distribution. Historically, the class average grade is 2.85 (B/B-) but we can give higher grades if your performance warrants it.
- Special Attention Is Always Given to the C/C- Decision.

FA 12Scale		
Min Ave	Max Ave	Grade
97	100	A+
93	97	A
90	93	A-
87	90	B+
83	87	B
80	83	B-
77	80	C+
73	77	C
70	73	C-
60	70	D
0	60	E

Late Policies

- Problem Sets May Not Be Turned In Late For Credit Under Any Circumstances
  - Solutions will be posted on Ctools Soon After the Due Date/Time
  - Medical or other legitimate reasons remove that particular problem set from your overall average
  - The Lowest Homework Score Will Be Dropped
- If You Have to Miss an Exam
  - I Need *Real* Documentation As To Why
    - The simple "patient was seen" form from UMHS is not acceptable
  - Must Actually Be A Serious Issue (Medical or Close Family Member Crisis)
  - I Don't Like E-mailed Excuses only Hours Before An Exam
    - It is likely that these e-mails will not be answered
    - Any considerations due to crisis in the last hours will be addressed on a merit basis after appropriate documentation is supplied

Special Circumstances

- If You Need Special Accommodations for Exams, You Must Submit The Appropriate Letter From UM Services for Students With Disabilities At Least 1 Week Prior To The Exam
- If You Are On A UM Athletic Team Or Have Another UM-Related Reason For Schedule Irregularities, Written Notice And Appropriate Documentation Is Needed Within University Guidelines

Keys to Success I

- Stay Up to Date
  - Each Incremental Concept/Method Is Not Hard But If You Get Behind It Will "Snowball" On You
- Come to Class
  - Helps Keep You Up to Date
  - You or Somebody Paid For It, So Why Not?
    - ~$44-141/lecture-hour in <u>direct</u> costs (i.e. only tuition, not living expenses, books, etc.) for this class
  - <u>Unannounced</u> Quizzes and Other In-Class Participation Events (including simple attendance checks) will account for 5% of your grade

Keys to Success II

- Do the Problem Sets. Do as much as you can on your own, then:
  - Seek help in collaboration with fellow students
  - GSI's, IA's, Professors
  - Always do the problem sets even if you can't finish 100%
  - Compare your solutions, both methods and final answers to the posted solutions (*keeping a copy of your work is suggested – scan it and save it*)

Keys to Success III

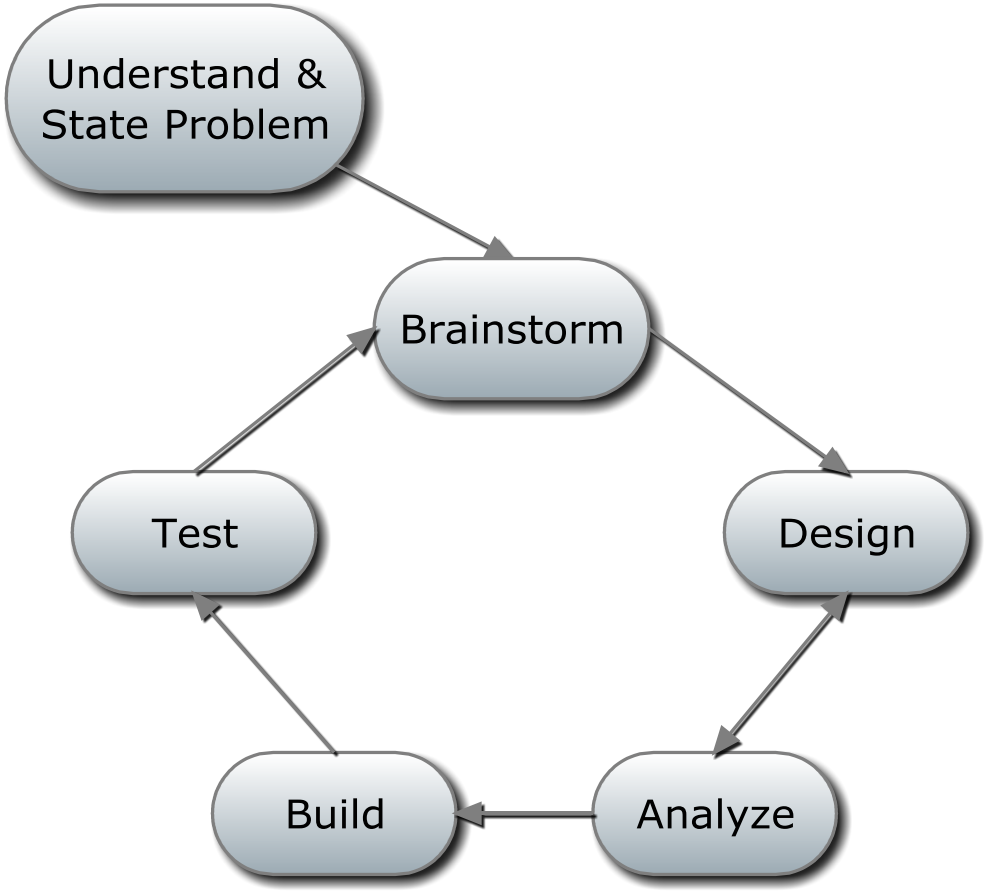
- Before an Exam, Do One or More of the Recent Exams In A Real, Timed Situation Without Looking at the Solutions
  - Honestly Grade Your Own Performance
- Qualitative Understanding Without A Demonstrated Ability to Quantitatively Execute Will Not Be Sufficient
- Keep Up With Labs, Learn and Have Fun, But Don't Expect the Your Lab Scores To Save Your Grade

Labs

- Lab Objectives:
  - Make some lecture concepts “real”
  - Gain Hardware Experience
  - Experience in data collection and technical reporting
  - Have some fun
- Labs begin week of Sept. 16
  - Do your pre-lab in advance (none for next week)
  - Come to lab on time and prepare (GSI/IA and room time is limited)
  - Lab Manual is Free Download. Details on this will be announced later
- Room 1016 EECS Bldg.

Engineering: Solving Problems

- Engineering Process (lots of variation on this theme)



Introductory Comments

- The major objective of 215 is for you to *understand* how linear circuits work and how to analyze them
  - The objective is ***NOT*** to train you in a set of procedures that you apply through pattern recognition. Computer software already exists to do this and it's cheaper than you!
- While many interesting applications require nonlinear as well as linear circuits, our understanding of linear circuits provides an outstanding basis for understanding all electrical systems
- The tools of linear circuit analysis are applied in other linear systems analysis problems, including mechanical, fluidic, and thermal systems.

Introductory Comments

- This class will use relatively few basic concepts and rules, but they must be used correctly and logically.
  - Some find this good, but remember that E&M uses only 4 equations (Maxwell's) and (non-relativistic) quantum mechanics uses only one (Schrodinger's or Dirac's). How many statement types are there in C++?
- All the problems assigned for homeworks and exams will have one and only one answer
  - Often, you can compute it exactly
  - Usually, it is possible to check your final answers to see if you satisfy all the circuit rules (If you do, you know the answer is correct. If you don't, you know you are not right).
  - You can almost always numerically check the answer with Multisim

Introductory Comments

- Exams will be constructed so that most points come from correctly specifying the equations that you must solve for the final answer. Mistakes in the setup indicate problems in physical understanding. Relatively few points will be assigned for final numerics.
- However, calculators which perform complex number & matrix calculation (ex. TI-89) will be allowed on exams. Sometimes it is advantage to be able crunch the numbers, find an error, and then go back. However, random button pushing will never get you there!

Research
Undergraduate Program
Graduate Program
ECE @ MICHIGAN
Outreach
Alumni
Industrial Programs
NeuroNexus Technologies
Making the connection
ePack
solving MEMS packaging
INTRALASE
accuri
CYTOMETERS
Clark-MXR, Inc.
ISSYS
INTEGRATED SENSING SYSTEMS
XTERA®
PICOMETRIX
an API company
evigia
OPTEOS
PICOCAL
Discera
micro communication technologies.
Quantum Signal, LLC
Signal Processing Solutions
Mobius
Microsystems

What is Electrical & Computer Engineering?

Electrical & Computer Engineering is:

The Soul: thoughts, feelings, ideas

The Brain: Process everything that the body needs or wants to do

Nerves/Spine: Carry all the important information

Expressions: Voice, controlled movements

Senses: feel the surroundings, vision, smell, taste, touch, smell

Cells: Nanotechnology and elements that make up the body, neurons

Blood: Energy that feeds the whole body, electrical, thermal, magnetic, radiative, mechanical

If Engineering is the Human

Evolution & Revolution of ECE

Communication
Computation
Radio/TV
Instrumentation
Control
…

Physics

Power Gen/Dist
Electric Machines
Communication
Optics
Electronics
…
Power!

Math

ECE

Materials

Semiconductors
Optics
Sensors/MEMS
Nano
…

Computing
Sensing
Synthetic Biology
Complexity
…

Bio

ECE Deals with Information/energy

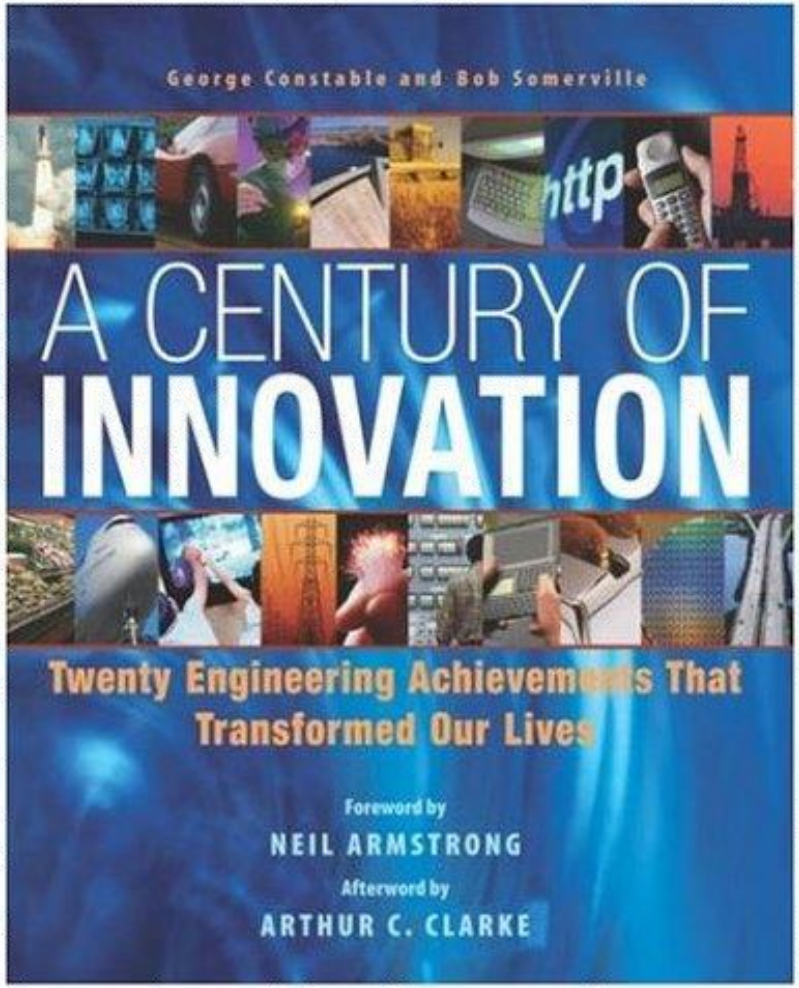
- Acquisition
- Transmission
- Storage
- Processing
- Delivery
- Management

→

- Communications
- Control
- Computer Vision
- Signal Processing
- Circuits
- VLSI
- Sensors (MEMS)
- Optics
- Electromagnetics
- Solid-State Devices & Nanotechnology

ECE Engineers Have Been the Innovators & Enablers

Innovation and Accomplishment



The 20 Engineering Achievements That Transformed Our Lives – mostly made possible through electrical and computer engineers!

- Electrification
- Electronics
- Radio and Television
- Computers
- Telephony
- Internet (fiber optic technology)
- Imaging
- Spacecraft
- Lasers and Fiber Optics
- Health Technologies
- Household Appliances
- High Performance Materials
- Automobile
- Airplane
- Air Conditioning and Refrigeration
- Highways
- Agricultural Mechanization
- Water Supply and Distribution
- Nuclear Technologies
- Petroleum and Petrochemical Tech.

Eras of Modern Science and Technology

~1900-1950: **The Age of Physics**

1897 J.J. Thompson discovers the electron

1900 Max Planck introduces the Quantum Concept

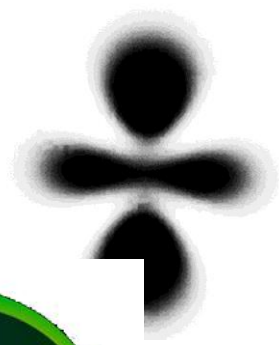
1905 Einstein $E = mc^2$

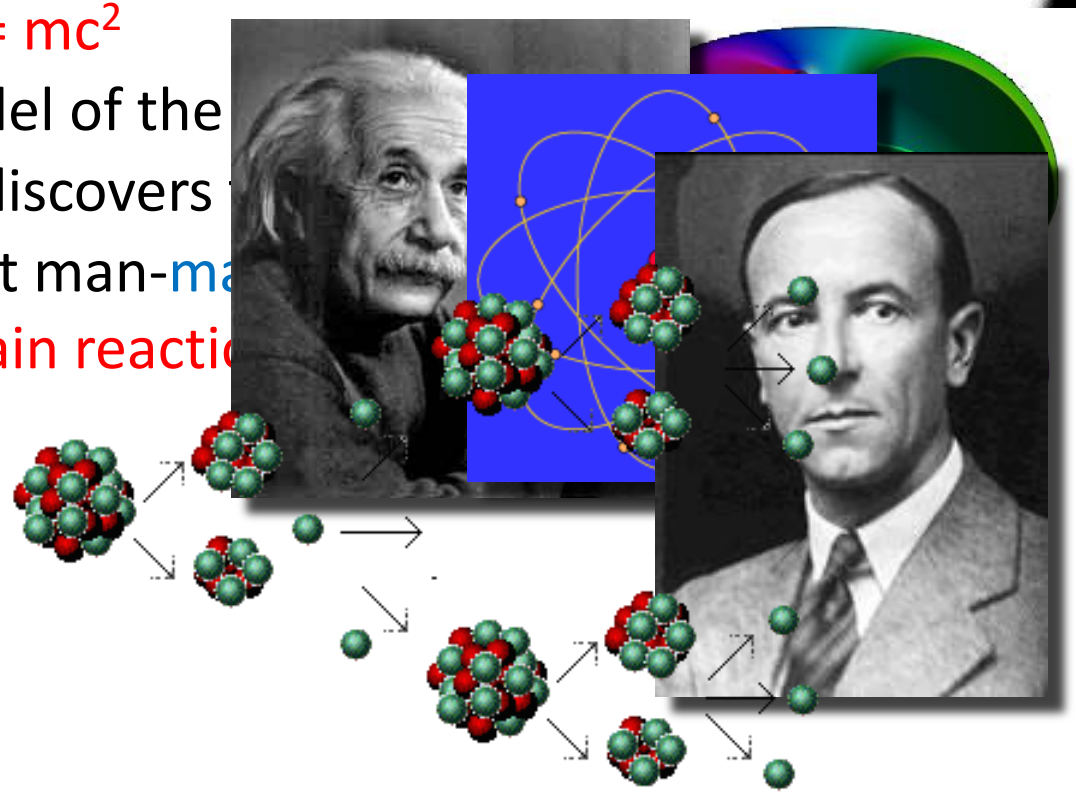
1913 Bohr's model of the

1932 Chadwick discovers

1942 Fermi - First man-ma

nuclear chain reacti





Eras of Modern Science and Technology

~1950-2000: **The Age of Electronics**

1947 Shockley & colleagues develop the junction transistor at Bell Labs

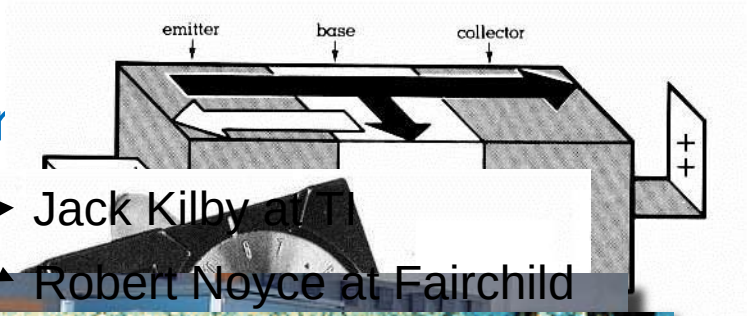
1954 Texas Instruments - First AM Tr

1958 First Integrated Circuit

1960 PDP-1 Microcomputer

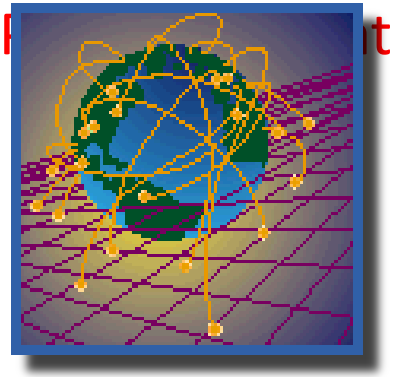
1969 ARPANET → **Internet**

1971 TI I tor



Jack Kilby at TI

Robert Noyce at Fairchild



Eras of Modern Science and Technology

~1950-2000: **The Age of Electronics**

1976 Apple 1 in kit form

1980 Microsoft r

1981 IBM-PC

1989 World Wid

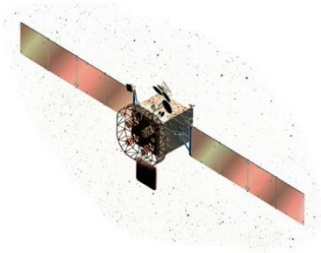
2002 Cell phone

2007 Wireless LE

Eras of Modern Science and Technology

~1950-2000: **The Age of Electronics**

Space

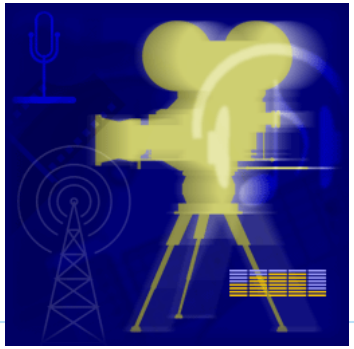


Transportation Systems

Manufacturing

Food Production

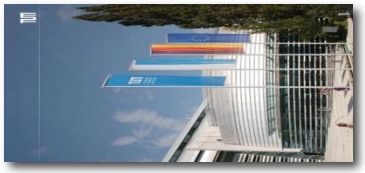
Entertainment

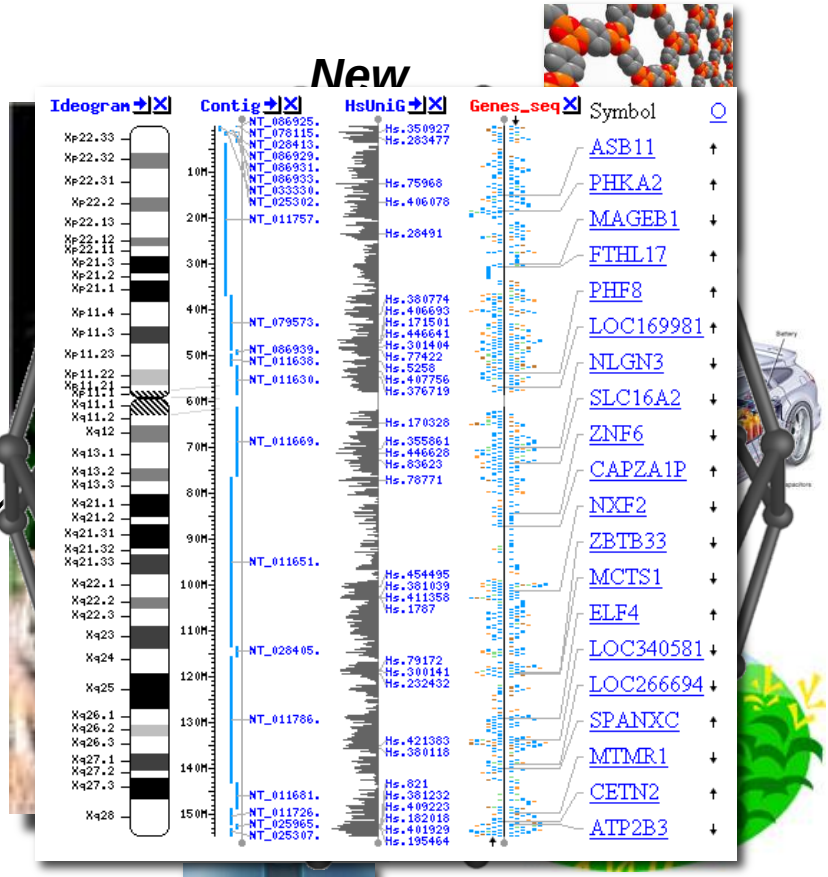


Health

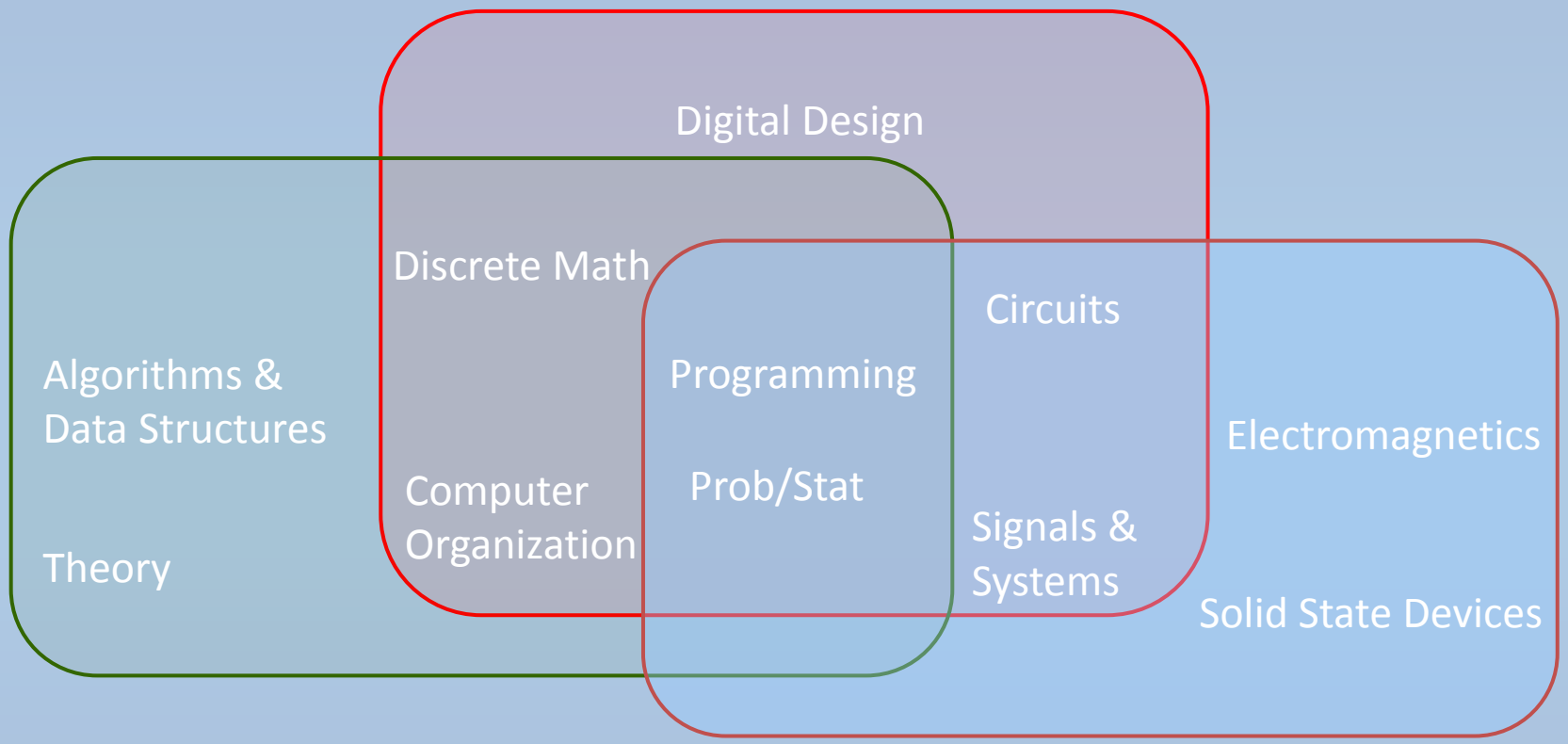
Eras of Modern Science and Technology

~2000-2050: **The Age of ? ? ?**





EECS Undergraduate Degree Programs



All 3 programs also require EECS 496 (Professionalism, 2 credits) teaming, entrepreneurship, ethics, …

ECE Degree Programs

Graduate Programs

M.S. and Ph.D. degrees in:

Electrical Engineering

Applied Electromagnetics and RF Circuits, Circuits & Microsystems, Optics and Photonics, Solid State, VLSI

Electrical Engineering: Systems

Control, Communications, Signal Processing. New areas under development: Computer Vision, Power & Energy

Undergraduate Programs

B.S.E. degrees in:

Electrical Engineering
Computer Engineering

Minors and Special Programs:

Electrical Engineering (for non-EECS students)
International Minor
Multidisciplinary Design
Eng. Global Leadership Honors Program
Entrepreneurship Certificate
Systems Engineering Certificate

Four Years to Your EE Degree

Year 1
The Foundation

- Intro to Eng.
- Program-ming
- Chem
- Physics
- Math
- Math
- Hum./SS
- Hum./SS

Year 2
Intro to EE

- Circuits
- Signals & Systems
- Physics
- Program-ming
- Math
- Math
- Hum./SS
- Hum./SS

Year 3
Define Your Area

- Electro-magnetics
- Prob. Methods
- Semicon-ductors
- Elective
- Elective
- Elective
- Elective
- Elective

Year 4
Plan your Career

- Elective
- Major Design Course
- Elective
- Technical Comm.
- Elective
- Elective
- Elective
- Elective

Required for all Programs

Humanities/Social Sciences

EE/CE Courses

EE Courses

Choice of EE and other courses

Four Years to Your CE Degree

Year 1
The Foundation

- Intro to Eng.
- Program-ming
- Physics
- Chem
- Math
- Math
- Hum./ SS
- Hum./ SS

Year 2
Intro to CE

- Discrete Math
- Circuits
- Physics
- Program-ming
- Logic
- Math
- Elective
- Hum./ SS

Year 3
Define Your Area

- Signals & Systems
- Prog./ Math/or Stat
- Computer Org.
- Elective
- Math
- Elective
- Elective
- Hum./ SS

Year 4
Plan your Career

- Elective
- Major Design Course
- Elective
- Technical Comm.
- Elective
- Elective
- Elective
- Elective

Required for all Programs

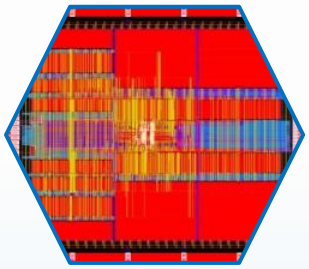
Humanities/Social Sciences

CE/EE Courses

CE Courses

Choice of CE and other courses

Major Design Experience – Teams and Special Projects



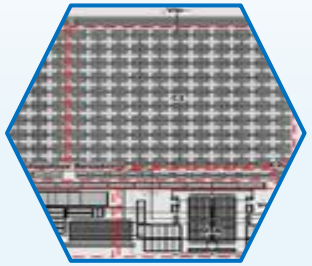
VLSI Design: design a 16-bit RISC microprocessor using industry-standard design tools. Students can fabricate their projects.

Digital Signal Processing: design and implement a real-time software package or hardware device. Recent projects: guitar autotuner, wireless electrocardiogram, wireless device to measure boat racer's strokes.

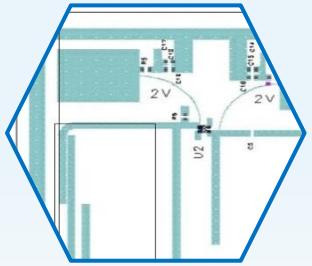
Radiowave Propagation and Link Design: design, build, and characterize a practical radio link. Recent projects: GPS tracking system, antenna system, wireless link between 2 PCs, a satellite ground station.

Advanced Lasers and Optics Lab: design and set-up a practical optical system. Recent projects: tunable fiber laser, solar light concentrator for the Solar Car, laser for the space elevator competition.

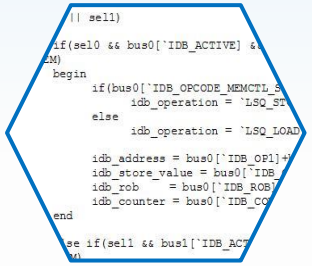
Integrated Microsystems Lab: design and fabricate an integrated microsystem in the LNF. Recent projects: integrated MOS-photodiode imager, digital micromirrors, microphone, self-testing Pirani gauge.



Monolithic Amplifier Circuits: analysis and design of BJT and MOS integrated operational, and multi-transistor amplifiers.



Microwave Circuits: design, fabrication, and measurements of microwave-integrated circuits using CAD tools and network analyzers.

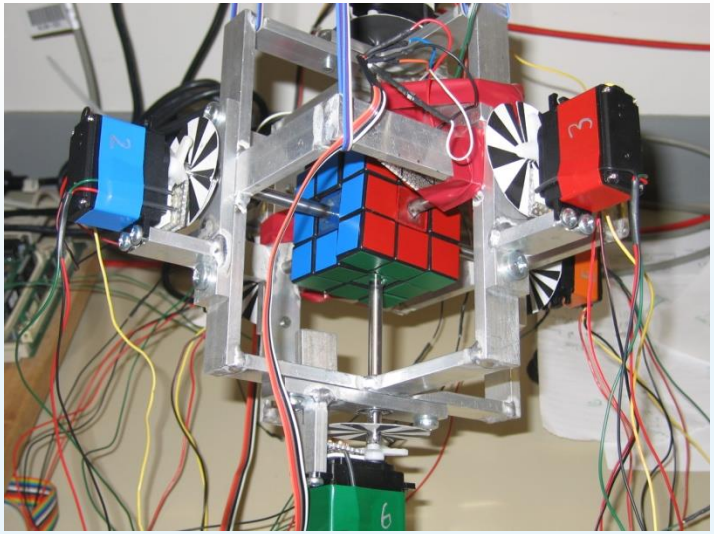


Computer Architecture: build a synthesizable out-of-order processor using Alpha architecture. Learn computer design methodology.

Design of Microprocessor Based Systems

The goal of this project was to design a robotic creature which would be able to move independently and climb a ladder. The creature's body consists of two arms, connected to a central tail. The arms were built using Legos, which were connected to three servo motors, and the ladder was built from craft wood.

video on YouTube



The goal of this project was to design and build a machine to autonomously speed-solve the classic 3x3x3 Rubik's Cube in less than 45 seconds. The students achieved a solve in 38 seconds.

video on YouTube

EE and the Environment

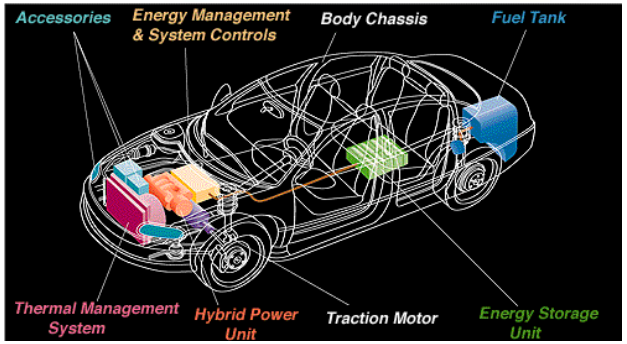
Electromagnetics:

Remote sensing of the earth's terrain and vegetation using radiometric imaging and polarimetric radar has applications for weather prediction and modeling, and global warming.

http://www.eecs.umich.edu/RADLAB

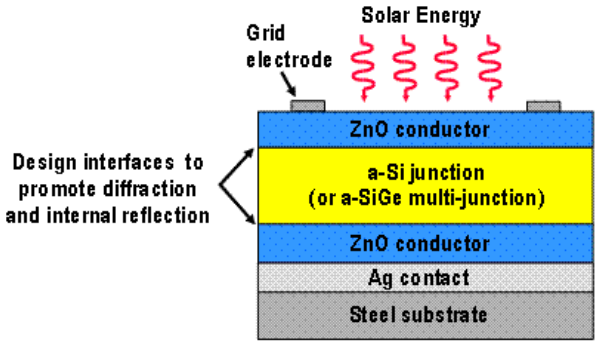
EEs develop many other sensing technologies

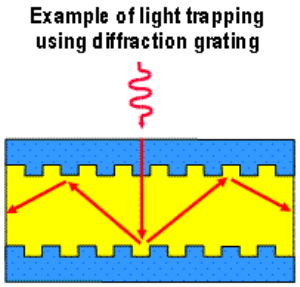
Wireless integrated microsystems (WIMS) center is developing sensors for bio-molecules, ionizing radiation, pressure, temperature, humidity, …



Hybrid vehicles - sophisticated electronics and control systems impact fuel efficiency

EE and Energy





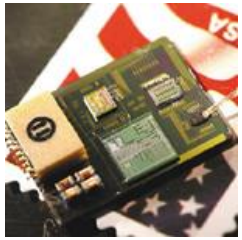
Solar cell technology:

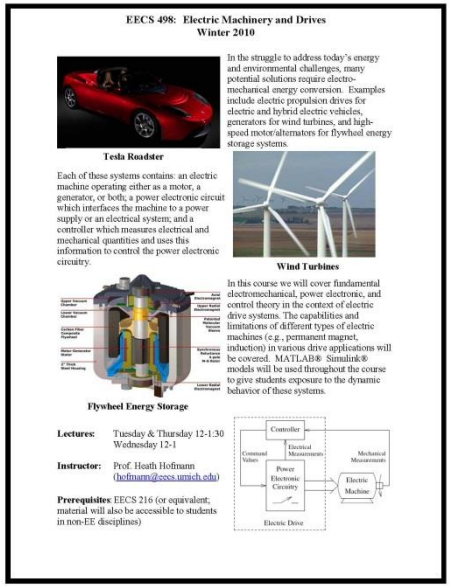
Improving efficiency through new materials and new electronic device structures

Power systems and electronics, electric vehicles

- Prof. Ian Hiskens: energy Systems
- Prof. Heath Hofmann: Power Electronics, etc.
- Several courses

Low-power electronics:
numerous projects





EECS 498: Electric Machinery and Drives
Winter 2010

In the struggle to address today's energy and environmental challenges, many potential solutions require electro-mechanical energy conversion. Examples include electric propulsion drives for electric and hybrid electric vehicles, generators for wind turbines, and high-speed motor/alternators for flywheel energy storage systems.

Tesla Roadster

Each of these systems contains: an electric machine operating either as a motor, a generator, or both; a power electronic circuit which interfaces the machine to a power supply or an electrical system; and a controller which measures electrical and mechanical quantities and uses this information to control the power electronic circuitry.

Wind Turbines

In this course we will cover fundamental electromechanical, power electronic, and control theory in the context of electric drive systems. The capabilities and limitations of different types of electric machines (e.g., permanent magnet, induction) in various drive applications will be covered. MATLAB® Simulink® models will be used throughout the course to give students exposure to the dynamic behavior of these systems.

Flywheel Energy Storage

Lectures: Tuesday & Thursday 12-1:30 Wednesday 12-1

Instructor: Prof. Heath Hofmann (hofmann@eecs.umich.edu)

Prerequisites: EECS 216 (or equivalent; material will also be accessible to students in non-EE disciplines)

Controller
Command Values
Electrical Measurements
Mechanical Measurements
Power Electronic Circuitry
Electric Machine
Electric Drive

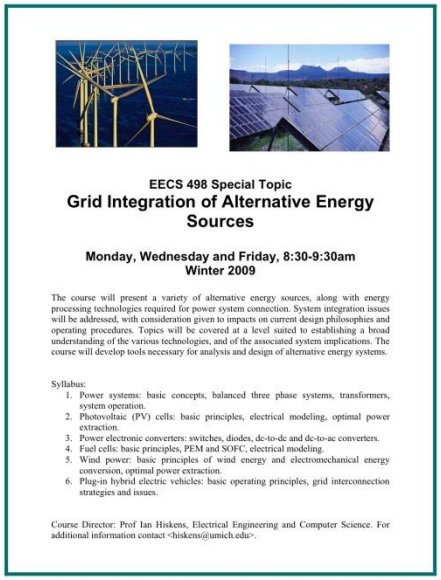
EECS 498-004 Special Topic
Power System Analysis and Design

Wednesday, 8:30-10:30am and Friday, 10:00am-Noon
Fall 2009

The course will establish the basic principles of power system operation and control, under normal conditions and when faults occur. It will develop the models and tools necessary for analysing system behavior, and provide opportunities for using those tools in design processes. Optimal generation dispatch will be developed, and electricity market implementation issues addressed. The impact of renewable generation on power system operation will be considered.

Syllabus:
1. Power systems: basic concepts, balanced three phase systems, per unit normalization.
2. Transformer and transmission line modeling.
3. Power flow analysis: formulation, decoupling relationships, system behavior, contingency analysis.
4. Power system operation: generation control, voltage control, energy management systems, renewable generation.
5. Electricity markets: economic dispatch, market implementation.
6. Power system protection: fault calculations, unbalanced operation, protection devices, system stability.

Course Director: Prof Ian Hiskens, Electrical Engineering and Computer Science. For additional information contact <hiskens@umich.edu>.



EECS 498 Special Topic
Grid Integration of Alternative Energy Sources

Monday, Wednesday and Friday, 8:30-9:30am
Winter 2009

The course will present a variety of alternative energy sources, along with energy processing technologies required for power system connection. System integration issues will be addressed, with consideration given to impacts on current design philosophies and operating procedures. Topics will be covered at a level suited to establishing a broad understanding of the various technologies, and of the associated system implications. The course will develop tools necessary for analysis and design of alternative energy systems.

Syllabus:
1. Power systems: basic concepts, balanced three phase systems, transformers, system operation.
2. Photovoltaic (PV) cells: basic principles, electrical modeling, optimal power extraction.
3. Power electronic converters: switches, diodes, dc-to-dc and dc-to-ac converters.
4. Fuel cells: basic principles, PEM and SOFC, electrical modeling.
5. Wind power: basic principles of wind energy and electromechanical energy conversion, optimal power extraction.
6. Plug-in hybrid electric vehicles: basic operating principles, grid interconnection strategies and issues.

Course Director: Prof Ian Hiskens, Electrical Engineering and Computer Science. For additional information contact <hiskens@umich.edu>.

Electrical and Computer Engineering
Department of Electrical Engineering and Computer Science

New Class for Fall 2009

POWER ELECTRONICS

EECS 498, Special Topics

Instructor: Prof. G. R. Lahiji roientan@umich.edu		Prerequisite:	EECS 215 or 314
		Time:	MW 3-4:30, F 3-4
		Credits:	4

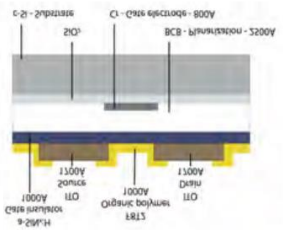
With the goal of preparing students for ongoing challenges in energy related areas, this class will teach the basics of analyzing and designing power electronic circuits to convert, control, monitor and regulate the flow of electrical energy in industrial, residential and transportational applications, and to manage renewable energy sources in a smart grid.

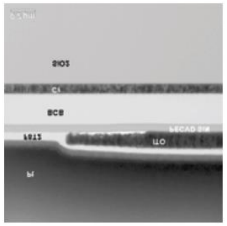
This course covers important aspects of power circuits, such as single- and three-phase systems, Faraday's and Ampere's Laws, and their application to the design of inductances and transformers. It also covers power devices such as diodes, thyristors, BJTs, MOSFETs and IGBTs, as well as their applications in converters and inverters, switching power supplies and smart power circuits. Unlike circuits and devices that are often designed to work with micro and nano watts, power electronic circuits and devices normally handle kilo and mega watts, requiring different approaches to designing reliable products.

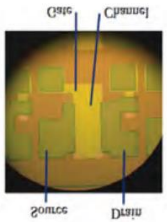
The class is intended for undergraduate and graduate students in electrical engineering, computer engineering, and other fields. No prior introduction to the subject is assumed.

EE Design Across Multiple Scales

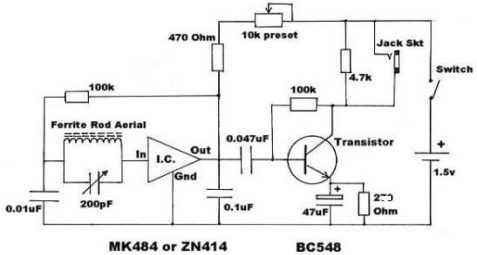
- EE majors design, analyze, build and test at many scales
- Devices

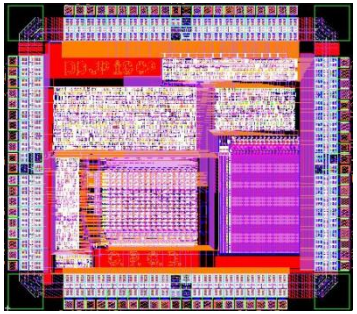




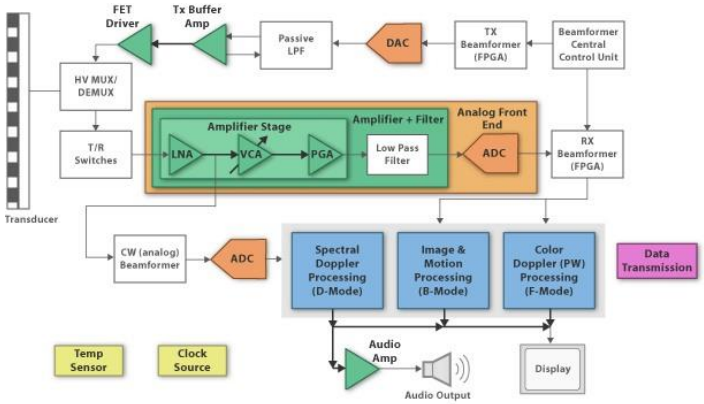


- Circuit / VLSI





- Subsystem
- System (GPS, power network, internet, …)
  in collaboration with many fields



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