******* WEEK 6 *******

WEEK 6 - ELECTRICAL ENGR (1.7h)

6.1 ELECTRICAL ENGINEERING

6.1.1 Description

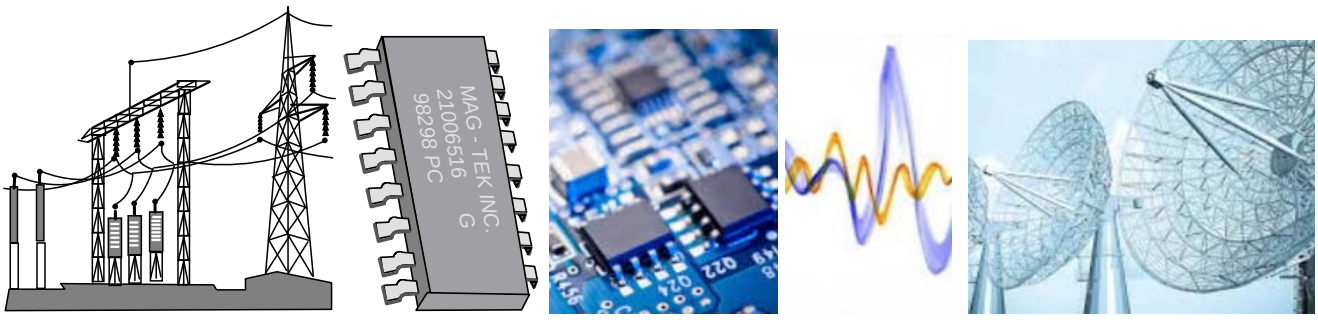
Design systems involving **electricity**, electronics, & electromagnetism.
Examples - electrical power generation & distribution (power grid), motors, radar & navigation systems, broadcast & communication systems, cell phones & GPS systems.

6.1.2 Electrical vs. Electronics Engr

Electrical – large-scale systems, like power generation & transmission, industrial systems
Electronic – small-scale systems, computers, integrated circuits

6.1.3 Sub-disciplines of EE

Power – generation, transmission, conversion, & distribution of electricity
Control – cruise control, microcontrollers, robots, motors
Electronics – transistors, computers, TVs, IC chip design
Signal processing – cell phones, TVs, stereos, home theater
Telecommunications – satellite systems, cell phone technology
Instrumentation – radar guns, sensors
Computers – tablets, cell phones, industrial computers



6.1.4 Where do you work?

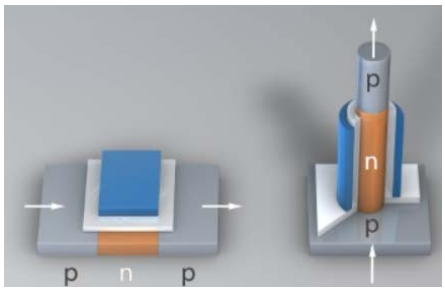
Manufacturing firms (electronics, computer, eg - Intel, AMD, Siemens), aerospace, automotive, biomedical...

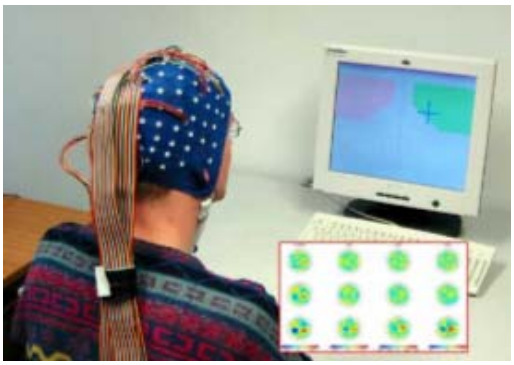
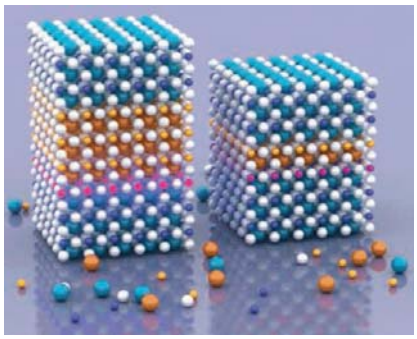
6.1.5 Professional Society

IEEE (Institute of Electrical & Electronic Engineers) – non-profit, most members of any technical professional organization in world (360K).

6.1.6 Challenges of EE

1. Nanotechnology, optics & photonics, faster solid-state electronics/computers
2. Artificial intelligence (smarter robots & machines), brain-computer interfaces
3. Energy systems (electrical power storage, smart grid)



6.2 ELECTRICITY

6.2.1 Electricity

Refer to the CT GUIDE (Chap 5)

Electricity is a FLOW OF ELECTRONS.
Electrons are part of the atom - the basic unit of matter.
Electrons move around the atom's nucleus (attracted to protons in nucleus).
But sometimes electrons can be knocked loose to form electricity.
Electrons that are easily knocked loose are FREE ELECTRONS.

CONDUCTORS are materials that have many free electrons.
INSULATORS are materials that have few free electrons.

6.2.2 Electrical quantities

Refer to the CT GUIDE (Chap 5.2)

Charge has units of COULOMBS (1 C = charge of 6.4×10^{18} electrons)
Current is the flow RATE of charge. It has units of AMPERES (or "amps"). (1A = 1 C/s)

Current in a branch or through an element in a circuit is drawn as an arrow.
Conventional current follows "flow" of (+) charge (opposite direction of electrons)

Voltage is electrical pressure and has units of VOLTS. Voltage is what pushes charge and creates electricity.

Voltage across an element is drawn as a (+) and a (-) on either side of the elements.

RESISTANCE

Resistance characterizes opposition to current. It has units of OHMS.

OHMS LAW

Ohm's Law relates voltage (V), current (I), and resistance (R) in a resistor.

6.2.3 Electric Circuits

Refer to the CT GUIDE (Chap 7)

An electric circuit is an interconnection of electrical elements.

There are different configurations in which to wire up components.

SERIES is when 2 (or more) components are wired one after another.
In series configuration the same current flows through each elements

PARALLEL configuration is when 2 or more elements are wired as shown below.
In parallel configuration the same voltage is across all elements in parallel.

6.2.4 Ohm's Law

Refer to the CT GUIDE (section 5.3)

6.2.5 Types of Electricity

Refer to the CT GUIDE (section 5.5)

There are 2 types of electricity. AC and DC

DC has constant voltage and current (e.g., batteries, DC power supplies)
AC has V and I that changes back and forth with time. The most common AC electricity is "sinusoidal" (seen below). This is the type of electricity that comes from an "AC" power outlet in your home.

6.3 ELECTRICITY PRODUCTION

There are different ways to make electricity: solar, wind, burning fossil fuels, hydroelectric, geothermal, nuclear, etc.

Presently, most electricity is produced by turning a **generator**. A generator turns coils of wire through a magnetic field. When this is done, electricity is produced. The rotating part of the generator does not turn

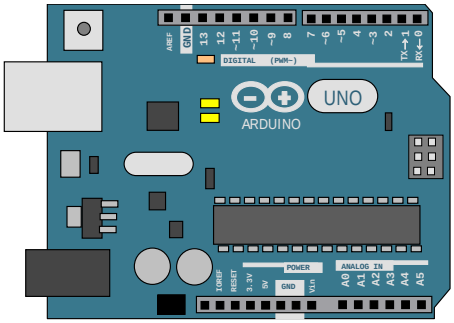
freely, but instead has mechanical resistance as it must overcome magnetic forces. Thus energy is required to turn the generator. A generator takes "mechanical work" (force over distance) and converts it into electrical energy. A generator can be thought of as just an electric motor in reverse (which takes electrical energy and produces mechanical work). Generators, due to their rotating motion, produce AC electricity.

Except for solar, all of the techniques noted involve turning a generator. The question is where the energy comes from and how does it produce movement (specifically rotation, or turning of shaft)

Solar - light energy knocks electrons loose in the semi-conductor material of the solar panel
Wind - wind forces turn the generator
Hydroelectric - water runs over turbine blades, turning a shaft
Geo-thermal - heat from deep in Earth is used to create steam, turning steam turbine

Natural gas - is burned in a gas turbine, which turns a shaft
Coal - is burned. The heat produces steam which turns a steam turbine
Nuclear - nuclear reaction creates heat, which is used to create steam, turning steam turbine

6.4 EE PROJECT (ARDUINO)



6.5 TECHNICAL TOPICS

WORK ON CE PROJECT (last chance!)

***** WEEK 7 *****

WEEK 7 - CE PROJECT DEMOs (1.2h)

FOR BRIDGE SIMULATOR - presentations by each student

FOR PHYSICAL BRIDGE-BUILDING PROJECT (not doing this presently):
- BREAKING BRIDGES (8 min/team) (1 - 1.5h)
- NO working on bridges on testing day.
- Reports are DUE at the START of class (no running off to print them out, print them BEFORE class)
- Immediately place your team report and bridge in the IMPOUND AREA.
- Instructor will inspect and weigh bridges.

(MOVE TO WK 6??)

EE PROJECT
(if doing teams, make teams)

ARDUINO PROJECT
- Intro to Arduino, electrical components, digital/analog, wire, Bb, Rs
- Possibly exercise 1

***** WEEK 8 *****

WEEK 8 - (OPEN DAY) - EE PROJ WORK

COUNSELING VISIT
FINANCIAL AID VISIT
CAREER CENTER

ARDUINO PROJECT (exercises 2, 3)

EXAM 3 REVIEW

EE, ELECTRICITY, PROJECT (WK 6)
Note - study both the class notes and any "cross-referenced" documents (like the CT Guide)

Definition, things worked on, (YES)
Difference between electrical and electronic engineering (YES)
Sub-disciplines – (YES, name 3 of 7)
Where you work – no
Professional society – (yes, & what "IEEE" stands for)
Branch emerging technologies – no

What is electricity? (YES)
Structure of atom, charge of protons, electrons (YES)
Rules for charge (YES)
Conductors vs. insulators – why they have this characteristic (free e') (YES)
Electric circuits - YES
Electricity variables (charge, current, voltage, resistance, power) – what they are – YES
Convention for current (opposite of electron flow) (YES)
Water analogy for the different circuit variables (YES)
Electricity concepts & electrical components
Ohm's Law (V=IR) – do simple calculations & unit conversions (YES)
DC vs. AC (YES)
How electricity is produced (YES)

Arduino Project Topics
Micro-controller – what are they, which one will we use – no
Digital vs. analog signals – difference between them – no
Solderless breadboard – what are they, terms (tie pt, terminal & bus strips) – no
Resistors – what they do, values are based on "color band" code - no
LED – know 2 leads (anode, cathode) – no

TECHNICAL – more complex unit conversion –no