ECE 101 F19 Lecture 1

Sept. 26, 2019

Course website:

https://ece101-fall19-01.courses.soe.ucsc.edu

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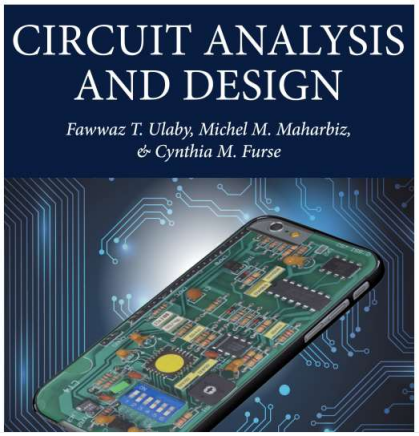
HW#1 (→ Quiz #1 next Th)

1) 1.1
2) 1.5
3) 1.14
4) 1.16 (b) & (c)
5) 1.25
6) 1.29
7) 1.31

→ will be in Qz 1 (15 minutes) no calculator.



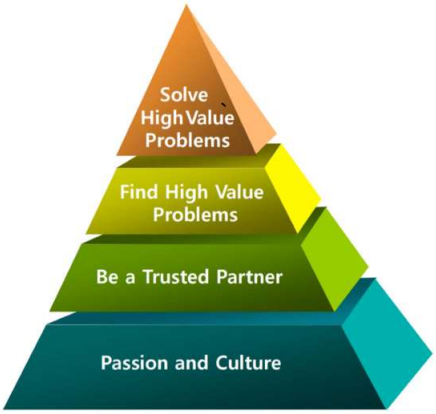
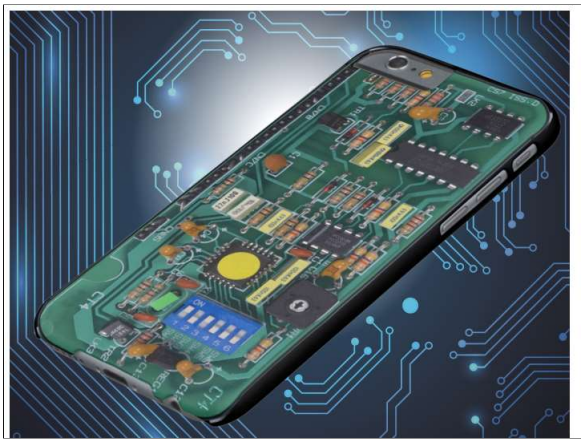


Figure 1-1: Cell phone.



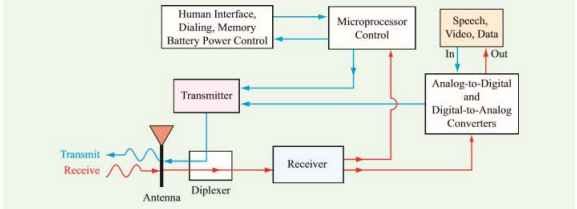


Figure 1-2: Basic cell-phone block diagram. Each block consists of multiple circuits that together provide the required functionality.

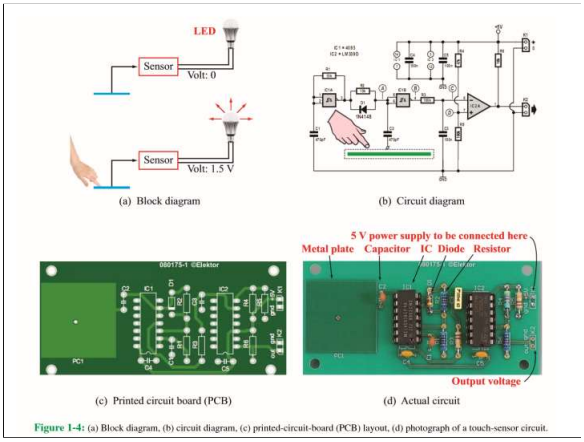
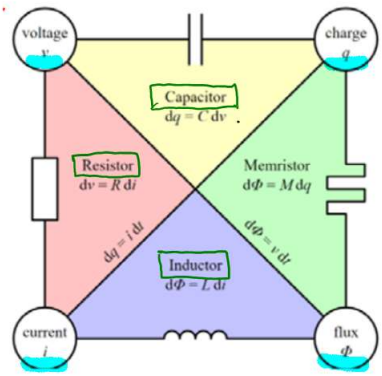
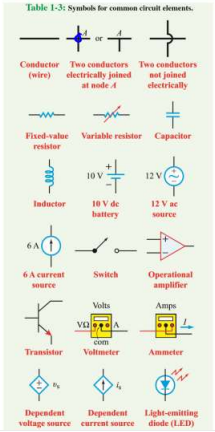


Figure 1-4: (a) Block diagram, (b) circuit diagram, (c) printed-circuit-board (PCB) layout, (d) photograph of a touch-sensor circuit.





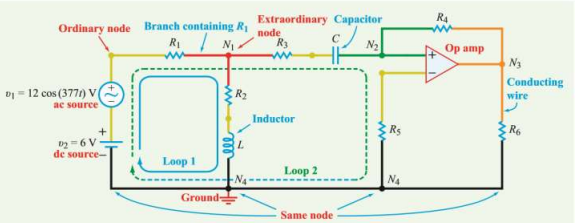


Figure 1-5: Diagram representing a circuit that contains dc and ac sources, passive elements (six resistors, one capacitor, and one inductor), and one active element (operational amplifier). Ordinary nodes are in yellow, extraordinary nodes in other colors, and the ground node in black.

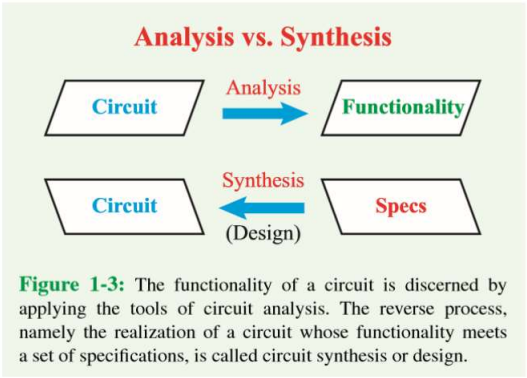


Figure 1-3: The functionality of a circuit is discerned by applying the tools of circuit analysis. The reverse process, namely the realization of a circuit whose functionality meets a set of specifications, is called circuit synthesis or design.

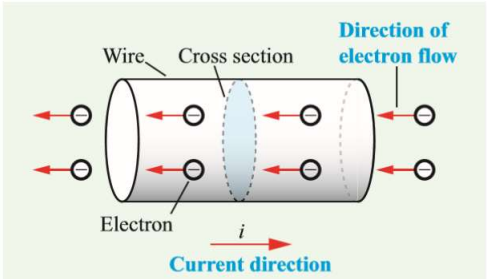
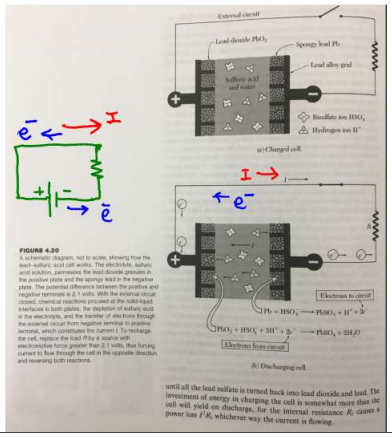


Figure 1-11: Direction of (positive) current flow through a conductor is opposite that of electrons.



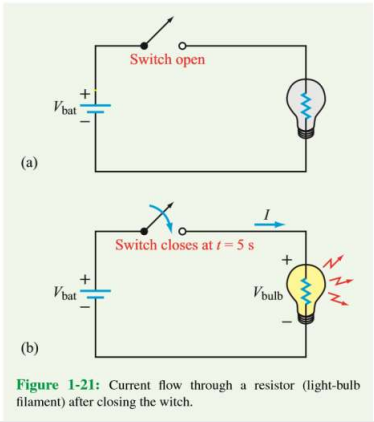


Figure 1-21: Current flow through a resistor (light-bulb filament) after closing the witch.

Table 1-1: Fundamental and electrical SI units.

Dimension	Unit	Symbol
Fundamental:		
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric charge	coulomb	C
Temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd
Electrical:		
Current	ampere	A
Voltage	volt	V
Resistance	ohm	Ω
Capacitance	farad	F
Inductance	henry	H
Power	watt	W
Frequency	hertz	Hz

Table 1-2: Multiple and submultiple prefixes.

Prefix	Symbol	Magnitude
exa	E	10^{18}
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}
atto	a	10^{-18}

1.2 Use appropriate multiple and submultiple prefixes to express the following quantities:

(a) 4.71×10^{-8} seconds (s) $47.1 \times 10^{-9}\,s = 47.1$ ns

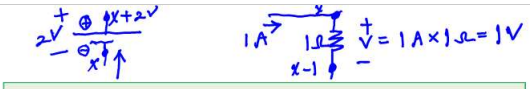
(b) 10.3×10^{8} watts (W)

(c) 0.00000000321 amps (A) 3.21 nA

(d) 0.1 meters (m)

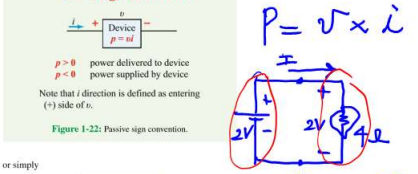
(e) 8,760,000 volts (V) 8.76 MV

(f) 3.16×10^{-16} hertz (Hz)



► A power supply, such as a battery, offers a ***voltage rise*** across it as we follow the current from the terminal at which it enters (denoted with a (−) sign) to the terminal from which it leaves (denoted with a (+) sign). In contrast, a power recipient (such as a light bulb) exhibits a ***voltage drop*** across its corresponding terminals. This set of assignments of voltage polarities relative to the direction of current flow for devices generating power versus those consuming power is known as the ***passive sign convention*** (**Fig. 1-22**). We will adhere to it throughout the book. ◄

Passive Sign Convention



$p > 0$ power delivered to device
$p < 0$ power supplied by device

Note that i direction is defined as entering (+) side of v.

Figure 1-22: Passive sign convention.

or simply

$$p = vi \quad \text{(W)}. \tag{1.9}$$

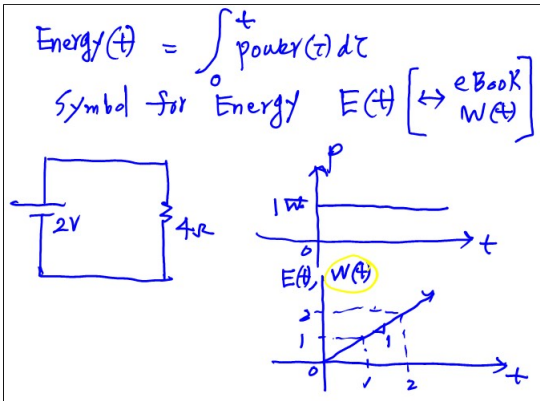
Consistent with the passive sign convention:

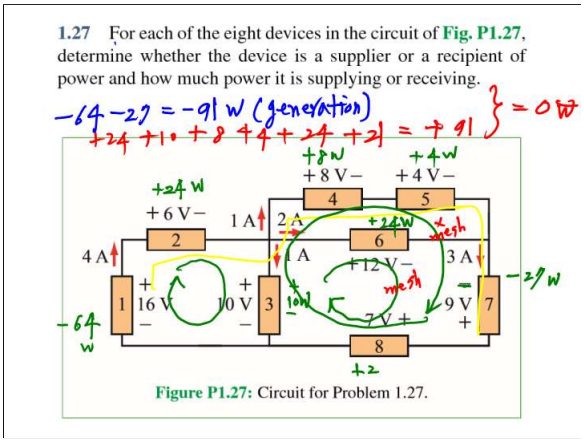
► The power delivered to a device is equal to the voltage across it multiplied by the current entering through its (+) voltage terminal. ◄

For example, a 100 W light bulb in a 120 V household electrical system draws 0.83 A of current.

If the algebraic value of p is negative, then the device is a supplier of energy. For an isolated electric circuit composed of multiple elements, the ***law of conservation of power*** requires that the algebraic sum of power for the entire circuit be always zero. That is, for a circuit with n elements,

$$\sum_{k=1}^{n} p_k = 0. \tag{1.10}$$





1.27 For each of the eight devices in the circuit of **Fig. P1.27**, determine whether the device is a supplier or a recipient of power and how much power it is supplying or receiving.

Figure P1.27: Circuit for Problem 1.27.

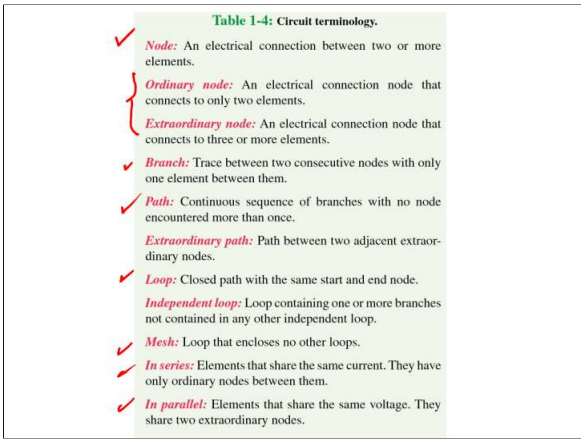
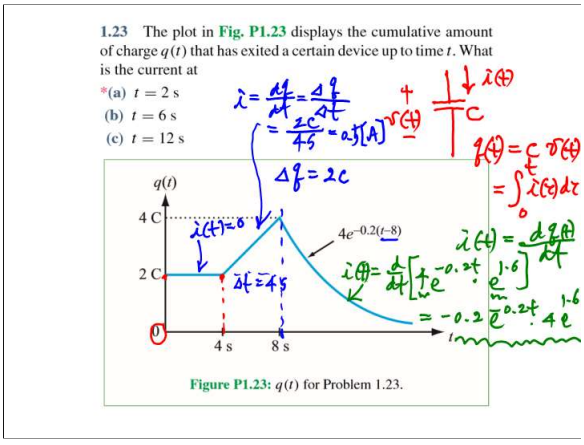


Table 1-4: Circuit terminology.

Node:	An electrical connection between two or more elements.
Ordinary node:	An electrical connection node that connects to only two elements.
Extraordinary node:	An electrical connection node that connects to three or more elements.
Branch:	Trace between two consecutive nodes with only one element between them.
Path:	Continuous sequence of branches with no node encountered more than once.
Extraordinary path:	Path between two adjacent extraordinary nodes.
Loop:	Closed path with the same start and end node.
Independent loop:	Loop containing one or more branches not contained in any other independent loop.
Mesh:	Loop that encloses no other loops.
In series:	Elements that share the same current. They have only ordinary nodes between them.
In parallel:	Elements that share the same voltage. They share two extraordinary nodes.



1.23 The plot in **Fig. P1.23** displays the cumulative amount of charge $q(t)$ that has exited a certain device up to time t. What is the current at

*(a) $t = 2$ s
(b) $t = 6$ s
(c) $t = 12$ s

Figure P1.23: $q(t)$ for Problem 1.23.

1.9 For the circuit in **Fig. P1.9**:

(a) Identify and label all distinct nodes.

(b) Which of those nodes are extraordinary nodes?

(c) Identify all combinations of 2 or more circuit elements that are connected in series.

(d) Identify pairs of circuit elements that are connected in parallel.

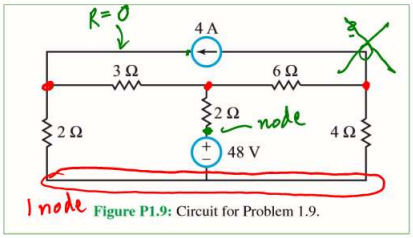
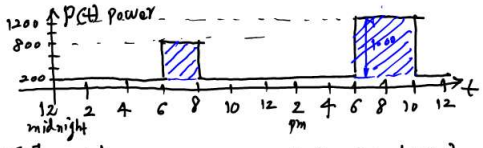


Figure P1.9: Circuit for Problem 1.9.



[Q] Total energy consumed in one day ?

$200 \times 24 = 4800$ w.hr

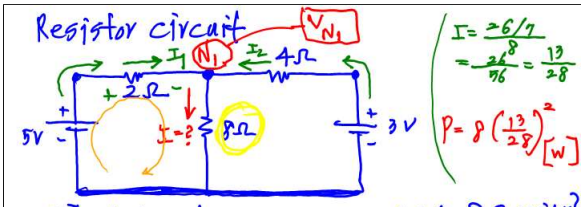
$600 \times 2 = 1200$ w.hr

$1000 \times 4 = 4000$ w.hr

$10{,}000$ w.hr $= 10$ Kwh

[Q] Average power $= P_{av} = W^{24hrs} / 24\,hr = \frac{10{,}000}{24}$

$= 0.416$ Kw



$I = \frac{5-3}{8} = \frac{2}{16} = \frac{1}{8}$

$P = 8\left(\frac{1}{8}\right)^2$ [W]

[Q] what is the power consumed by 8Ω resistor?

$I \times 8\Omega = 8I$ [V]

$P = 8I^2$ [W]

I [A]

$I_1 = \frac{5-V_{N1}}{2}$

$I_2 = \frac{3-V_{N1}}{4}$

$I = I_1 + I_2$

Mesh/Loop (KVL)

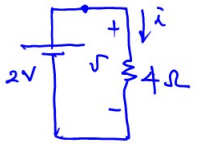
$0 = -5 + 2\left(\frac{5-V_{N1}}{2}\right) + 8\left(\frac{5-V_{N1}}{2}\right) + 3 - V_{N1}$

$= -5 + 5 - V_{N1} + 20 - 4V_{N1} + 6 - 2V_{N1}$

$7V_{N1} = 26 \Rightarrow V_{N1} = 26/7$ [V]

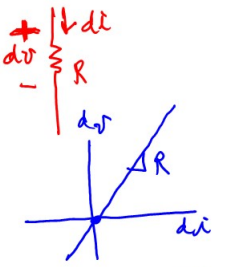
Ohm's Law

$dv = R\,di$

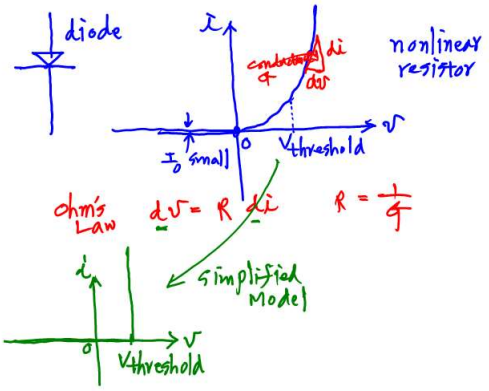


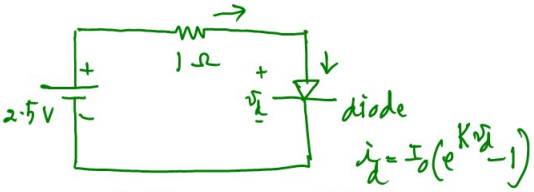
$v = 4i = 2V$

$i = \frac{2V}{4\Omega} = 0.5$ [A]



Linear resistor

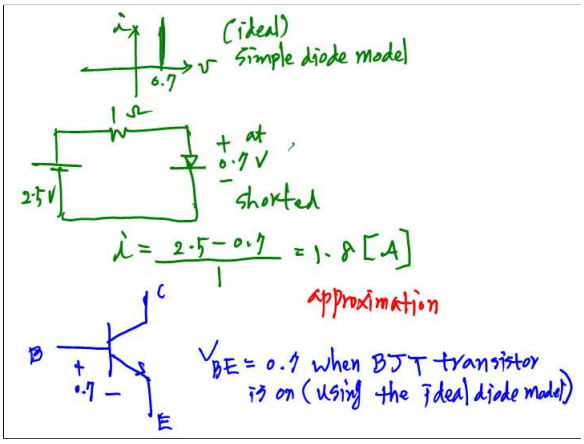




$i_d = I_0\left(e^{Kv_d} - 1\right)$

$\frac{2.5 - v_d}{1} = I_0\left(e^{Kv_d} - 1\right)$

solve v_d complex


(ideal)
simple diode model
0.7
1Ω
+ at
0.7V
−
shorted
2.5V
$i = \frac{2.5 - 0.7}{1} = 1.8\,[A]$
approximation
C
B
+
0.7 −
E
$V_{BE} = 0.7$ when BJT transistor is on (using the ideal diode model)