

Check the class website - read everything

- Important sections on safety, efficiency, lab writeups, schedule, etc.

Exam dates:

Quiz 1 - Thursday, April 19th - Week 3

Quiz 2 - Thursday, May 10th - Week 6

Quiz 3 - Thursday, May 31st - Week 9

Textbook - none

- we will use Professor Najmabadi's notes which are posted on the website.
- You will also find Sedra + Smith "Microelectronic Circuits" to be very helpful. Much of the material is also covered there.
- Professor Najmabadi also has slides posted on his website - you will find links on this quarter's website

Rules:

No rescheduling of exams! - for any reason!

Only acceptable excuses for missing are

- serious illness with doctor's note
- death in immediate family with similar documentation
- in these cases we count your other quizzes with appropriate weighting

No late lab reports!

- turn them in at your next lab section, one week later
- first lab is PSpice, each student does it individually
 - o Turn in at the Wednesday, April 18th lab section
- Last lab requires two weeks - turn in 10th week
- Labs 2-7 are done in teams of 2 students

- Syllabus - handout
- Website - on ECE Classweb
 - will not be using the WebCT site right now
- We will use Prof. Najmabadi's notes (on web site)

Introduction (review)

Circuit theory - 9 fundamental circuit elements

- Resistor $V = Ri$
- Capacitor $i = C \frac{dv}{dt}$ or $V = \frac{1}{s\omega C} I$
- Inductor $V = L \frac{di}{dt}$ or $V = s\omega L I$
- Independent voltage source $V = \text{constant}$
- Independent current source $i = \text{constant}$
- Four dependent sources

voltage	$\rightarrow$	voltage
current	$\rightarrow$	current
- Kirchoff's voltage law from Faraday's law

Stoke's theorem $\rightarrow \nabla \times \vec{E} = \frac{\partial \vec{B}}{\partial t} = 0$ (steady state)

$$\oint_C \vec{E} \cdot d\vec{l} = 0 \rightarrow \text{sum of voltage drops around a closed path is } 0$$

- Kirchoff's current law from charge-current continuity relation

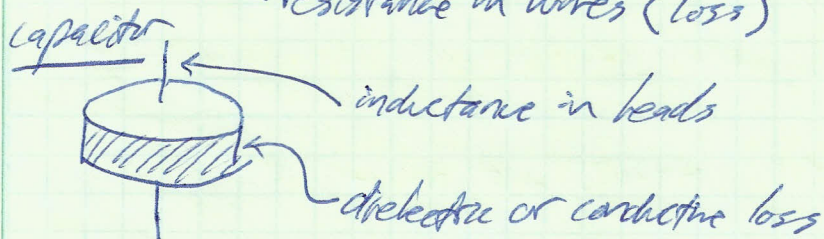
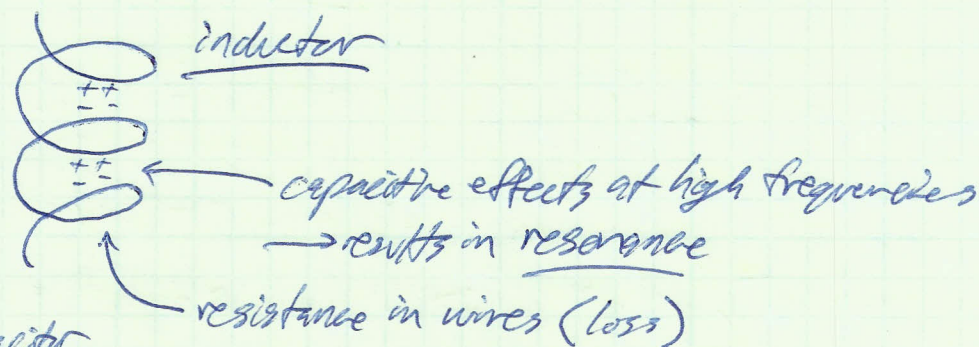
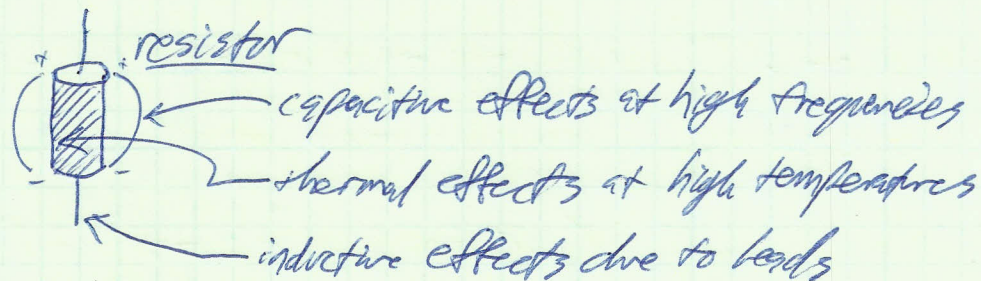
divergence theorem $\rightarrow \nabla \cdot \vec{J} = \frac{\partial \rho_v}{\partial t} = 0$ (steady state)

$$\oint_S \vec{J} \cdot d\vec{s} = 0$$

$$\sum_n I_n = 0 \rightarrow \text{sum of currents leaving a node is } 0$$

Applicability of circuit models

real vs. ideal elements



- Real device in lab is approximated by ideal device over a certain range of conditions
- Circuit theory allows us to use simple models instead of solving full electromagnetic/thermal/etc. problem
- Many of these effects can be included by adding parasitic elements
- KVL and KCL always apply
 - only question is whether you have modeled the real device properly

Basis of solving circuit problems

for a circuit with N_e elements, N_n nodes, N_l loops

- KVL + KCL : $2N$ equations
- Node voltage method : $N_n - 1 - N_{ivs}$ equations
 $\uparrow$ ground $\uparrow$ ind. voltage sources
- Mesh current method : $N_l - N_{ics}$ equations
 $\uparrow$ ind. current sources

Frequency Domain

time domain - explicit time dependence

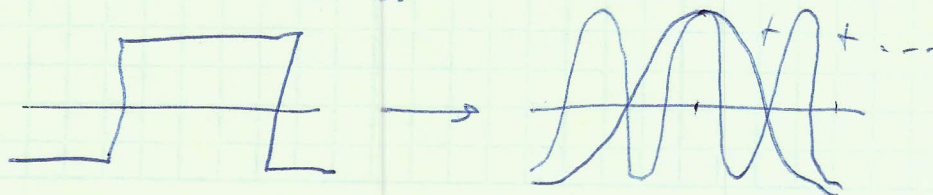
frequency domain - phasors = magnitude/phase at given frequency

$$i = C \frac{dv}{dt} \rightarrow V = \frac{1}{j\omega C} I$$

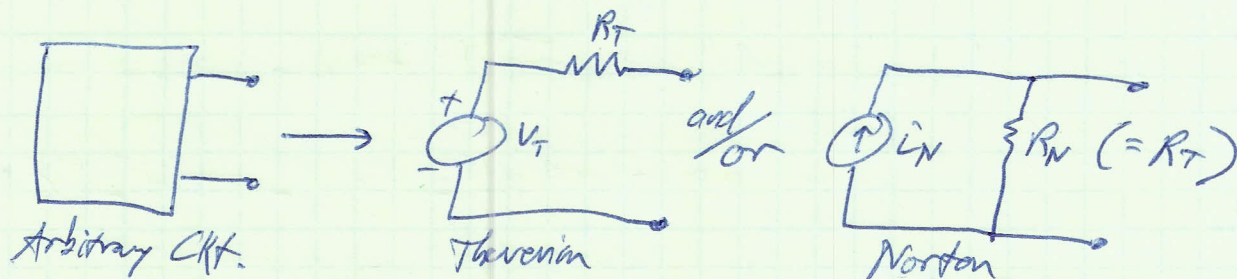
$$v = L \frac{di}{dt} \rightarrow V = j\omega L I$$

- linear circuits driven by sources with frequency ω
 $\rightarrow$ all currents and voltages will have frequency ω
 $\rightarrow$ for multiple frequencies, each response can be added up (superposition) so overall response is the sum of responses at each frequency
- Any periodic signal can be written as sum of sinusoidal functions using Fourier series expansion

Square wave :
$$V(t) = \frac{4V_m}{\pi} \left[\sin(\omega t) + \frac{1}{3} \sin(3\omega t) + \frac{1}{5} \sin(5\omega t) + \dots \right]$$

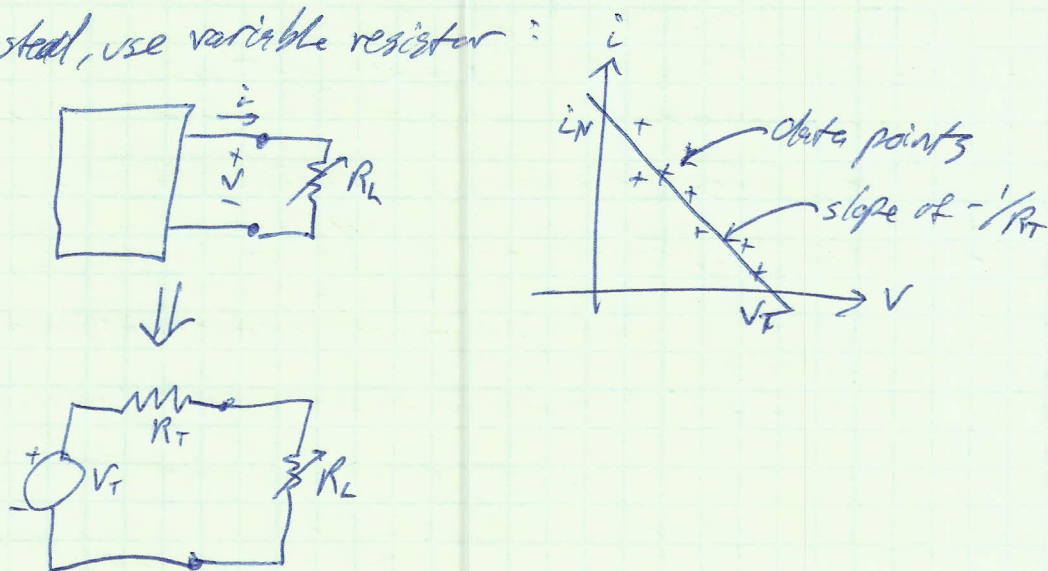


Thevenin + Norton Equivalents



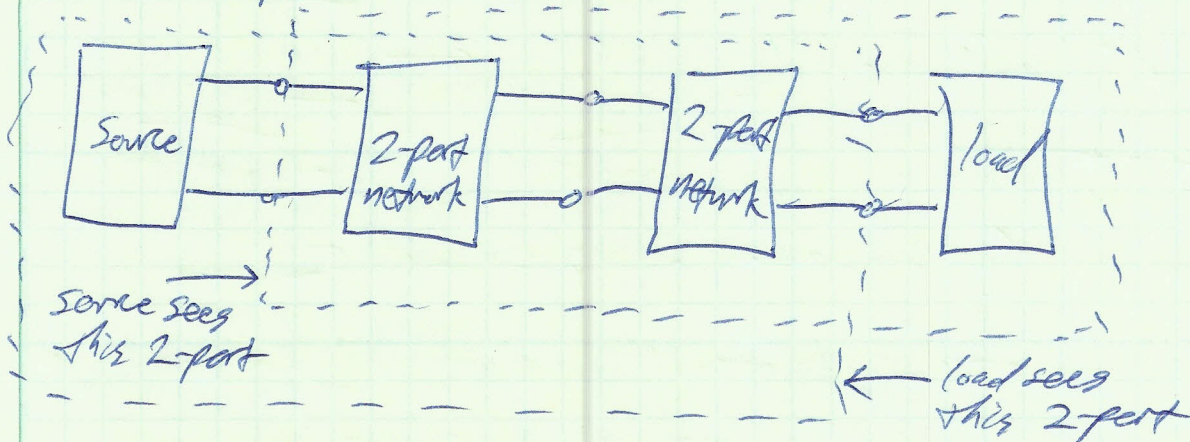
(use Z_T instead of R_T for frequency domain)

- How to find the Thevenin/Norton equivalents:
 - Zero the independent sources and calculate R_T
 - Find V_{oc} (open-circuit voltage) or I_{sc} (short-circuit current)
 - How to measure the Thevenin/Norton equivalents:
 - can't just short out the circuit (may damage it)
 - can't attach ohm-meter while circuit is turned on
 - measurement of open-circuit voltage affected by impedance of meter
- Instead, use variable resistor:



Cascading Circuits

Two-port networks



- We often don't solve complete circuits, but treat them as sub-circuits
- example: multi-stage amplifiers

Accuracy of Measurements:

- Instruments in this lab will have a tolerance - ϵ
and devices
- Value A can actually be anywhere in range of $A(1 \pm \epsilon)$
- Typical tolerance for resistors may be 1% or 5%
- a $1\text{ k}\Omega$ resistor may be anywhere from 950 to $1050\ \Omega$
- Do not report more digits than appropriate for a given measurement.