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Lecture 4: September 10th, 2001

Circuit Elements and Equivalent Circuits

A) Capacitors
B) Inductors
C) I versus V & Simplest Equivalent Circuit

Reading:
Schwarz and Oldham 5.1, 2.2, 3.1

Summary 1

- Capacitors: two plate example Q = CV, I = C dV/dt
  and V = (1/C) integral of voltage
- Computer example 1 mA current charging 1 pF
  $V(t) = (I/C)t = (10\text{-}3\ A/10^{-12}\ F)\ t = 10^9\ V/s\ t$
- At D.C. time derivatives are zero => C is open circuit
- C in parallel add; series 1/C = sum ($1/C_i$); short together (infinite current but conserve charge)
- Inductors: coil example Flux = LI, V = L dI/dt
  and I = (1/L) (integral of voltage)
- At D.C. time derivatives are zero => L is short circuit
- L in parallel 1/L = sum ($1/L_i$); series add; connect in series when have different currents => $L_1I_1+L_2I_2 = (L_1+L_2)I_{NEW}$

Summary 2

- I vs. V for ideal voltage source is a vertical line at $V = V_{SV}$
- I vs. V for ideal current source is a horizontal line at $I = I_{SC}$
- I vs. V for a circuit made up of ideal independent sources and resistors is a straight line.
- The simplest circuit for a straight line is an ideal voltage source and a resistor (Thevenin) or a current source and a parallel resistor (Norton)
- The easiest way to find the I vs. V line is to find the intercepts where $I = 0$ (open circuit voltage V_T) and where $V = 0$ (Short circuit current I_N)
- The short-cut for finding the $(\text{slope})^{-1} = R_T = R_N$ is to turn off all of the dependent sources to zero and find the remaining equivalent resistance between the terminals of the elements.