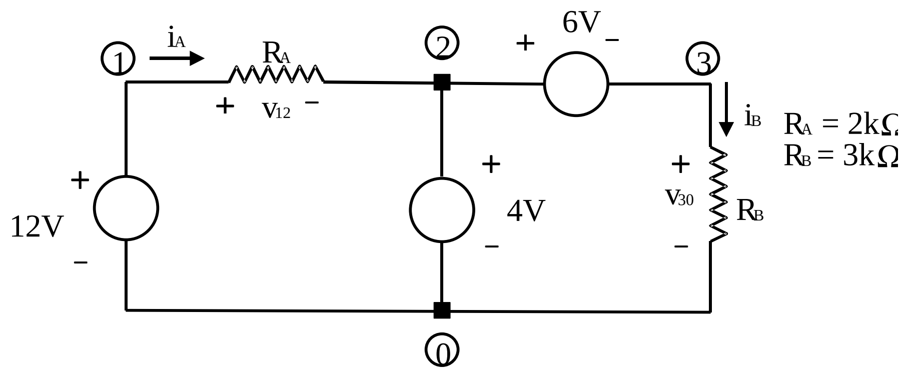
EECS 40 Summer 2002 Ben Wild

Problem Set 3

(Due Mon July 8 at 12PM)

Problem 1 Give the values of the DC current and voltages indicated in the following circuit. Warning: you must get the sign correct to get the right answer!

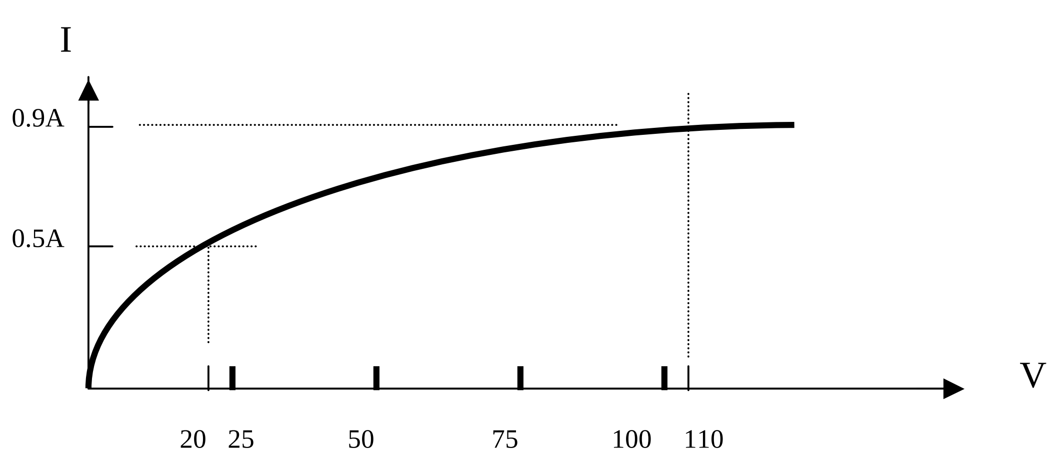


In this problem let Node 0 be the reference node (that's where you put the "common" or black probe of your voltmeter when you measure node voltages).

(a) v_1 =
(b) v_2 =
(c) v_{12} =
(d) v_{30} =
(e) v_{32} =
(f) i_A =
(g) i_B =
(h) Find the power flowing into R_A.
(i) Find the power supplied by the 12V source.
(j) Find the power supplied by the 4V source.

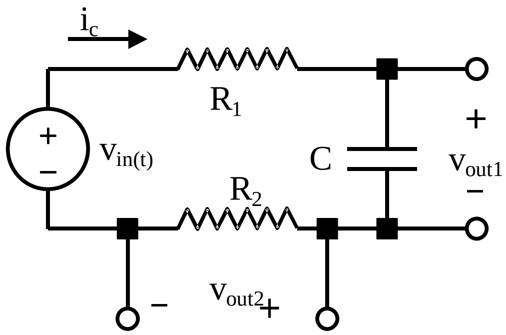
Problem 2 1) The weird non-linear circuit element N_1 of Figure 3.17 on page 106 of the text is placed across a power supply with voltageVs. Thus V_{AB} = Vs. How much power does the power supply deliver to N_1 if Vs is:
a) 5V (Note: just read the graph as accurately as you can, the answer is of course approximate.),
b) 0V. (Can you explain this answer - after all the current is not zero is it?)

Problem 3 A light bulb has the I-V characteristics shown below. It is normally used at 110V .



a) What should be the nominal wattage rating of this bulb (i.e. the power dissipated when it is in a 110V circuit) (Round off to the nearest multiple of 5W in all parts of this problem).
b) How much power does it dissipate when it has only 20V across it?
c) If you had only the data points for current at V = 0 and V=110, you might assume this was a resistor. What would you estimate the resistance value to be?
d) Calculate the current and the power for a resistor that has the resistance of part c, at a voltage of 20V.
e) So does Ohm's law work for a nonlinear device like the light bulb? (answer is NO) Why not?

Problem 4 The circuit below has a time varying voltage source v_{in} which is a simple 3V step function at $t = t_1$ (i.e. $v_{in} = 0$ for all $t < t_1$ and $v_{in} = 3V$ for all $t > t_1$). In this problem t_1 = 50msec.



$R_1 = 5k\Omega$; $R_2 = 5k\Omega$; $C = 1\mu F$

(a) How could you construct the source V_{in} (t) from a 3V battery and a switch (draw the circuit)?
(b) What is the initial value of V_{out1} (that is the value of the capacitor voltage for $t < t_1$)?
(c) Find $v_{out1}(t)$ at $t = t_{1+}$ (that is just at the very start of the transient).
(d) Given the answer to part (c) can you say how much voltage is dropped across each of the resistors at this same instant $t = t_{1+}$? (Hint: Each resistor drops half the difference of V_{in} less V_{out1}).
(e) What is the circuit time constant?
Plot:
(f) $V_{out1}(t)$
(g) i_c (t). (Hint: Combine the resistors together to simplify the circuit and make use of your knowledge of capacitors to be able to find i_c (t). at $t = t_1$ and $t >> RC$)
(h) V_{out2} (t) Same axes as in (c) (Hint: apply ohm's law on resistor R_2 only.)

(i) Write equations for the capacitor voltages $V_{out1}(t)$, $V_{out2}(t)$ and current i_c (t).

Problem 5

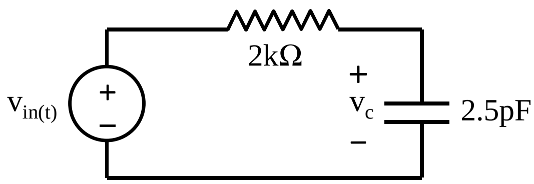


Figure 5.1

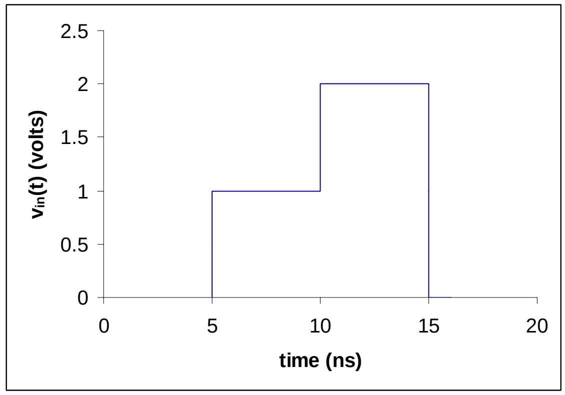


Figure 5.2

The circuit in Figure 5.1 has a v_{in} waveform shown in Figure 5.2. Assume that the capacitor is uncharged at t = 0.

(a) Sketch $v_c(t)$. That means find initial and asymptotic values, sketch, and write the equation for $V_c(t)$. Hint: There are three transient problems here! First solve the problem for the first voltage step ignoring the second step, and so forth. Calculate X, the voltage at t = 10nsec based on the first transient solution. This is of course the initial capacitor voltage for the second part of the problem (a capacitor having an initial voltage of X, with an input voltage of 2V applied at t = 10ns). Then there is a third problem in which the input drops to zero, so you must again calculate the exact voltage at t=15nsec (from the solution to the second part) which is the initial condition for the third part.

(b) Write the equations for the curves in the different time regions: t < 5nsec, 5nsec < t < 10nsec, 10nsec < t < 15nsec, and t > 15nsec