01/31/03 Corrected

EECS 42 – Introduction to Electronics for Computer Science

Spring 2003, **Prof. A. R. Neureuther**
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Problem Set # 2

Due 2:30 PM February 5th, 2003 in box in 240 Cory

Reading: Section 1.3-1.4, 2.1-2.2 Schwarz and Oldham. Next week 2.2, 3.1-3.4, 5.1

2.1 Flow. A wire of radius 1 mm contains 2 x 10^{22} electrons/cm^3. The electrons are moving from right to left at an average velocity of 20 cm per second. A reference plane is perpendicular to the wire.

a) Find the number of electrons per second passing through the reference plane.
b) Find the current from left to right.
c) How long does it take for 1 Coulomb of charge to pass through the reference plane?

2.2 Kirchhoff's Current Law (KCL). The circuit shown in Figure P2.2 shows currents through branches with assigned directions.

a) Apply KCL at node A to get a relationship between currents I_1 through I_4.
b) Apply KCL at node B to get a relationship between currents I_3 through I_5.
c) Place a bag around elements 3 and 4 that also encloses both node A and B in the bag and then apply KCL to the bag.
d) Show that the equation found in c) can be found by combining the equations found in a) and b).

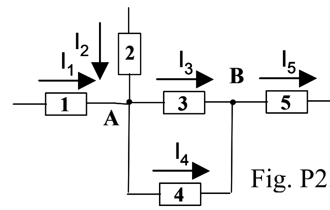

Fig. P2.2

2.3 Kirchhoff's Voltage law. Suppose that you are walking through the circuit shown in Figure P2.3 and experience the potential changes across the elements along your path. $V_1 = 6V$, $V_2 = 3V$, $V_3 = -1V$, $V_5 = 1V$, $V_6 = 5V$.

a) Find the potential increase if you walk from node E to node C via elements 1 to 3.
b) Find the potential increase if you walk from node E to node C via elements 5 to 6.
c) Use KVL around the closed loop (window) defined by nodes A, B, D and E to find V_{BD}.
d) Use KVL around the closed loop (window) defined by nodes D, B and C.
e) Combine the algebraic loop equations from d) from c) to eliminate V_{BD} and show that the result is KVL around the closed loop defined by nodes E, A, B, C, D.

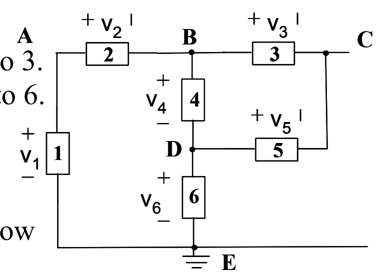

Fig. P2.3

2.4 Resistor network currents and power. A resistor network is shown in Figure P2.4.

$I_{IN} = 1$ mA, $V_A = 2.2V$, $V_B = 1.2V$, $R_2 = 2k\Omega$

a) Find the value of the resistor R_1.
b) Find the current through R_2.
c) Use KCL at node B to find the current through R_3 and the value of R_3.
d) Use the current into the network and the voltage V_{AC} to find the power flowing into the network.
e) Compute I^2R for each resistor, add them and compare to d).

2.5 I vs.V model for a resistor network. Again use the circuit in Figure P2.4 with the values for R1 and R3 found in Problem 2.4. For this problem the input current is allowed to take on values from –1mA to +1mA and the voltages V_A and V_B then adjust themselves.

a) Plot the input current versus voltage on R_1.
b) Plot the input current versus voltage V_B.
c) Plot the input current versus voltage V_A by combining points from a) and b).
d) Find the slope of curve c). Then compare the inverse of this slope with the resistance found by combining R_2 and R_3 in parallel and then adding R_1 in series.

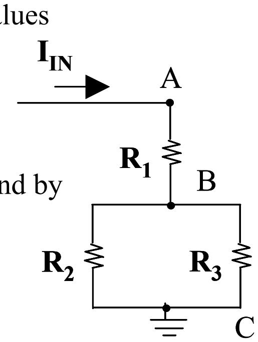

Fig. P2.4