02/05/03 Corrected Version

EECS 42 – Introduction to Electronics for Computer Science

Spring 2003, **Prof. A. R. Neureuther**

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Solution to problem Set # 2 (Farinaz Koushanfar)

2.1 Flow.

a) Number_of_e/s = (density)(velocity)(area) = (2×10^{22} electrons/cm^3) (20 cm/s)(π)$(0.1)^2$ = 1.26×10^{22} electrons/s

b) Current = (Number_of_e/s) × (charge_e) = (1.26×10^{22}) × -(-1.6×10^{-19}) = 2011 A

c) Time = Charge/Current = 1/2011 = 5×10^{-4} s

2.2 Kirchhoff's Current Law (KCL).

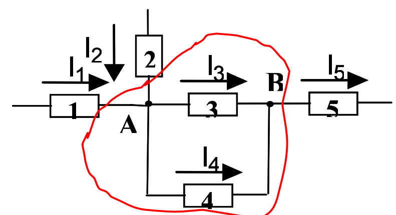

Fig. P2.2

a) $I_1 + I_2 - I_3 - I_4 = 0$

b) $I_3 + I_4 - I_5 = 0$

c) $I_1 + I_2 - I_5 = 0$

d) From a), $I_1 + I_2 = I_3 + I_4$, from b) $I_3 + I_4 - I_5 = 0 \Rightarrow I_1 + I_2 = I_5$

$\Rightarrow I_1 + I_2 - I_5 = 0$

2.3 Kirchhoff's Voltage law.

a) Potential Increase (from E to C via 1-3) = $v_1 - v_2 - v_3 = 6\text{-}3\text{+}1\text{=}4$v

b) Potential Increase (from E to C via 5-6) = $v_6 - v_5 = 5\text{-}1\text{=}4$v

c) $V_{BD} = v_4 \Rightarrow - v_1 + v_2 + v_4 + v_6 = 0 \Rightarrow v_4 = 6 - 3 - 5 = -2$v

d) $v_4 + v_5 - v_3 = 0$

e) KVL(E, A, B, C, D) = d)-c) = $v_4 + v_5 - v_3 - (- v_1 + v_2 + v_4 + v_6) = v_5 - v_3 + v_1 - v_2 - v_6 = 0$

KVL (E, A, B, C, D) = $v_5 - v_3 - v_2 + v_1 - v_6 = 0$

2.4 Resistor network currents and power.

a) $V_{AB} = 2.2 - 1.2 = 1\text{v} \Rightarrow R_1 = V_{AB}/I_{IN} = 1\ \text{k}\Omega$

b) $V_{AB} = R_2 I_2 \Rightarrow I_2 = V_B/2\text{k}\Omega = 0.6$ mA

c) $I_{IN} - I_2 - I_3 = 0 \Rightarrow I_3 = I_{IN} - I_2 = 1 - 0.6 = 0.4$ mA

$\Rightarrow R_3 = V_B/I_3 = 1.2/0.4 = 3\ \text{k}\Omega$

d) $I_{IN}V_{AC} = 2.2 \times 1\text{mA} = 2.2$ w

e) Compute I^2R for each resistor, add them and compare to d).

$I_{IN}^2R_1 + I_2^2R_2 + I_3^2R_3 = 1\text{w} + 0.72\text{ w} + 0.48\text{ w} = 2.2\text{ w}$

2.5 I vs.V model for a resistor network.

a) Plot the input current versus voltage on R_1. ($R_1 I_{IN} = V_{AB}$)

b) Plot the input current versus voltage V_B. ($V_B/R_2 + V_B/R_3 = I_{IN}$)

c) Plot the input current versus voltage V_A by combining points from b) and c).

$V_A = V_{AB} + V_B = R_1 I_{IN} + R_2 R_3/(R_2+R_3)\ I_{IN}$

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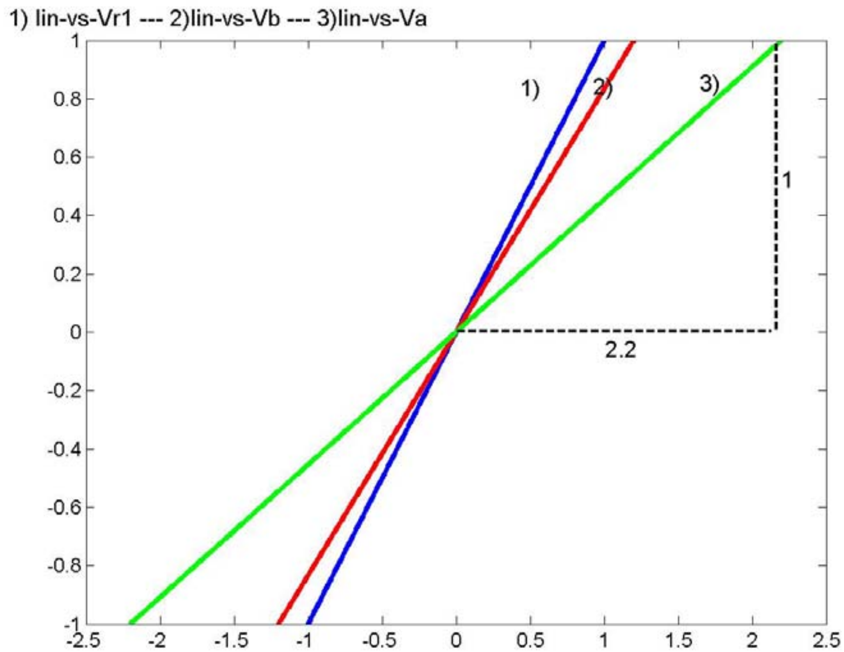

d) Find the slope of curve c). Then compare the inverse of this slope with the resistance found by combining R_2 and R_3 in parallel and then adding R_1 in series.

Slope = 1/2.2 = 0.4545 mA/V $\Rightarrow$ 1/slope = 2.2 kΩ

$R_{eq} = R_1 + R_2 \parallel R_3 = R_1 + R_2 R_3 / (R_2 + R_3) = 1+1.2 = 2.2$ kΩ

Thus, inverse of the slope and the R_{eq} are equal.