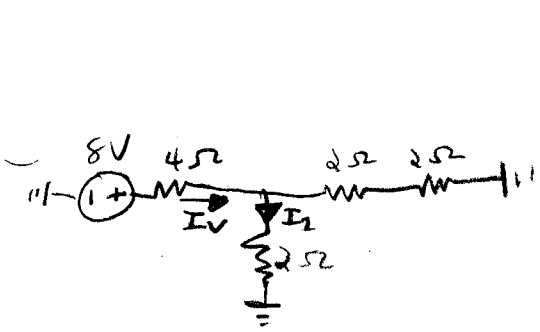
Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.002 - Electronic Circuits
Spring 2000

Quiz #1 Solutions
February 23, 2000
One Hour Closed Book

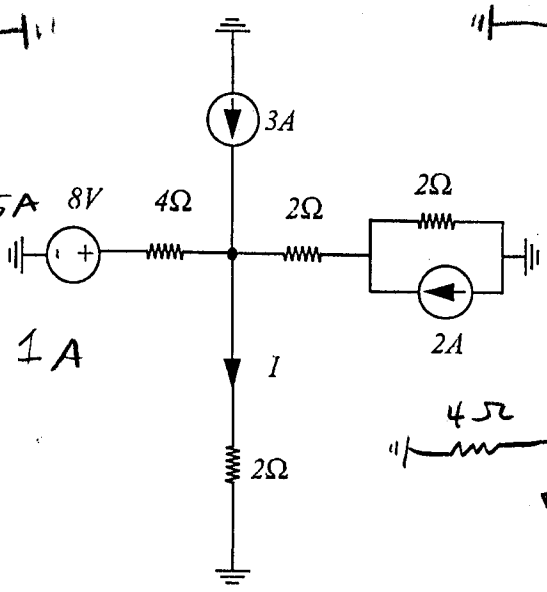
NOTE: Answer any 2 of the following 3 questions.

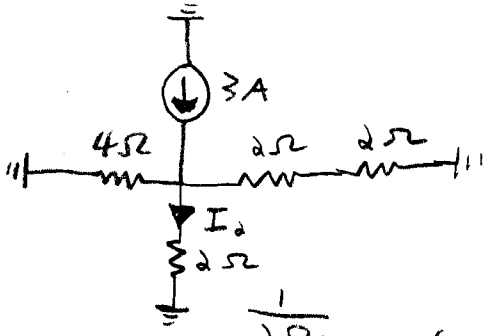
Problem #1
Find the current I in the circuit illustrated below: Superposition!



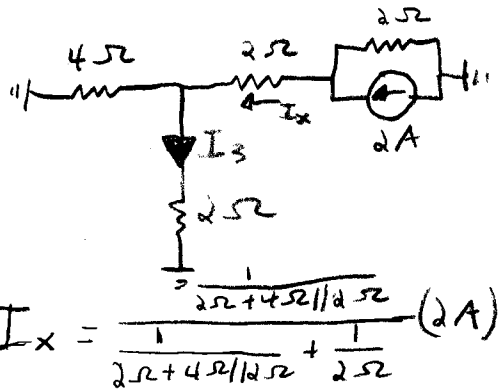
$$I_V = \frac{8V}{4\Omega + 2\Omega \| 4\Omega} = 1.5A$$

$$I_1 = \frac{\frac{1}{2\Omega}}{\frac{1}{2\Omega} + \frac{1}{4\Omega}} I_V = 1A$$





$$I_2 = \frac{\frac{1}{2\Omega}}{\frac{1}{4\Omega} + \frac{1}{4\Omega} + \frac{1}{2\Omega}} (3A) = 1.5A$$



$$I_x = \frac{\frac{1}{2\Omega + 4\Omega \| 2\Omega}}{\frac{1}{2\Omega + 4\Omega \| 2\Omega} + \frac{1}{2\Omega}} (2A) = 0.75A$$

$$I_3 = \frac{\frac{1}{2\Omega}}{\frac{1}{4\Omega} + \frac{1}{2\Omega}} I_x = 0.5A$$

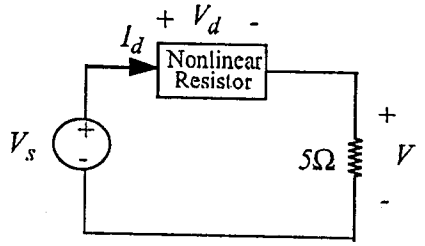
$$I = I_1 + I_2 + I_3$$
$$= 1 + 1.5 + 0.5$$

$$\boxed{I = 3A}$$

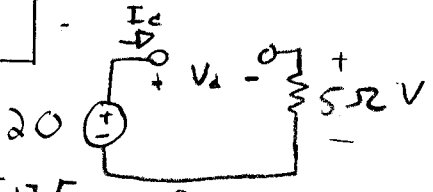
Solutions

Problem #2

Find the output voltage V in the circuit illustrated below:



Large signal: $V_s = 20V$



$V = I_d(5\Omega)$, $V + V_d = 20$

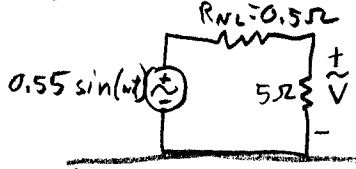
$I_d(5\Omega) + V_d = 20$

$I_d = 4A - \frac{V_d}{5\Omega}$ ⇒ see graph

cross at $I_d = 2A$, $V_d = 10V$

so $V = 20 - 10 = 10V$

small signal: Nonlin has slope $\approx \frac{4A}{2V} = \frac{1}{0.5\Omega} = \frac{1}{R_{NL}}$

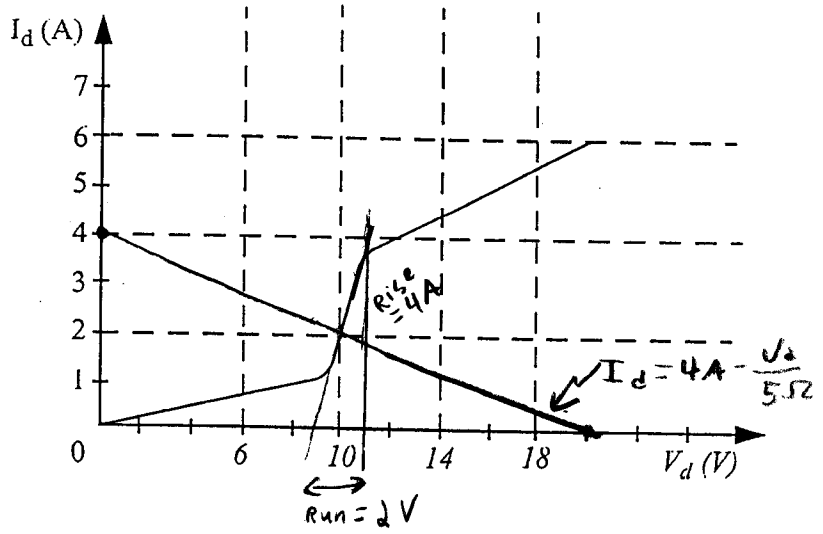


$\tilde{V} = \frac{5\Omega}{0.5\Omega + 5\Omega}[0.55\sin(\omega t)]$

$= 0.5\sin(\omega t)\ V$

$V = V + \tilde{V} = 10V + 0.5V\sin(\omega t)$

Assume that $V_s = 20V + 0.55V\sin(\omega t)$ and that the I_d-V_d characteristic of the nonlinear resistor is as shown below.

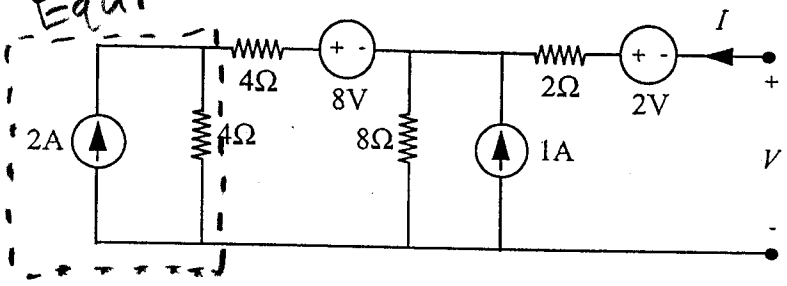


Solutions

Problem #3

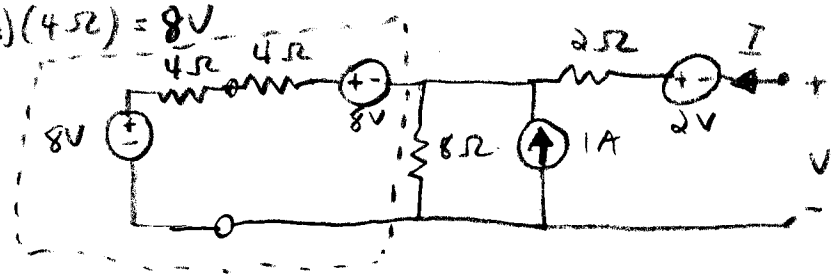
Find an analytic expression for the *V-I* relationship for the circuit illustrated below:

USE Thevenin / Norton Equivalents



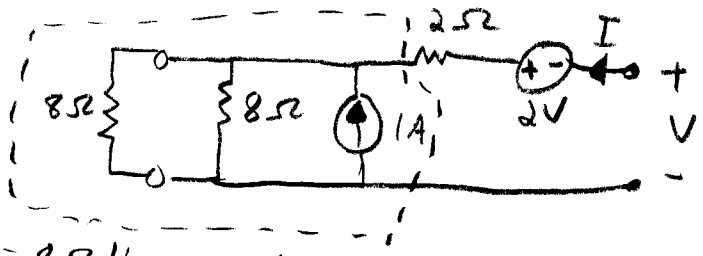
$V_{oc} = I_{sc} R_{TH}$

$= (2A)(4\Omega) = 8V$



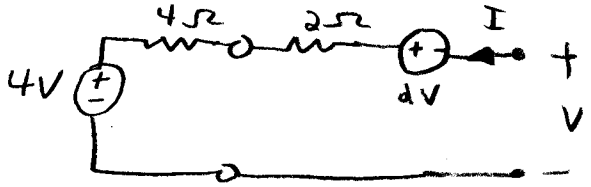
$V_{oc} = 0V$!

$R_{TH} = 8\Omega$



$R_{TH} = 8\Omega \,//\, 8\Omega = 4\Omega$

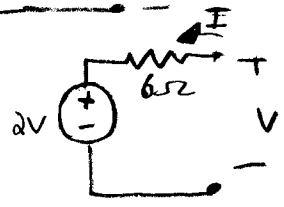
$V_{oc} = I_{sc} R_{TH} = (1A)(4\Omega) = 4V$



$V_{oc} = 2V$

$R_{TH} = 6\Omega$

$\Rightarrow$



$V = 2V + I(6\Omega)$