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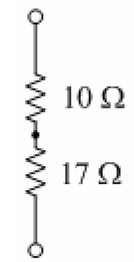
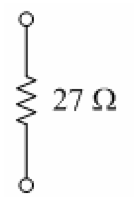
CASE WESTERN RESERVE UNIVERSITY
Case School of Engineering
Department of Electrical Engineering and Computer Science
ENGR 210. Introduction to Circuits and Instruments (4)

Quiz No. 3 2/6/04

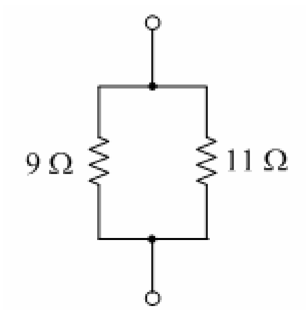
PUT ANSWERS IN THE SPACE PROVIDED AND SHOW YOUR WORK IF APPROPRIATE
STATE ALL ASSUMPTIONS

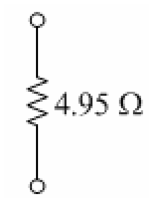
Problem 1 (10 points) In (a) and (b) show the equivalent circuit. In (c) and (d) transform the source. Be sure to indicate voltage and current directions.



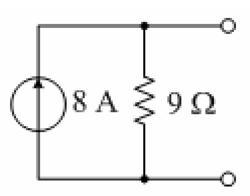


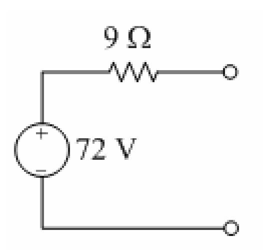
$R_{eq} = R_1 + R_2$; that is two resistors in series;



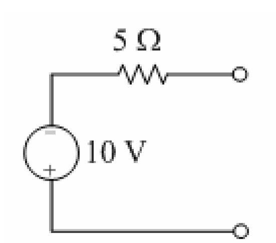


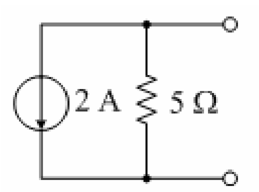
$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} \Rightarrow R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$; that is two resistors in parallel;





$V_{eq} = I_s R; R_{eq} = R$; detailed analysis refers to p.36 in textbook;





$I_{eq} = \frac{V_s}{R}; R_{eq} = R$; detailed analysis refers to p.37 in textbook;

Please note that the current directions of two circuits should be kept same after the transformation.

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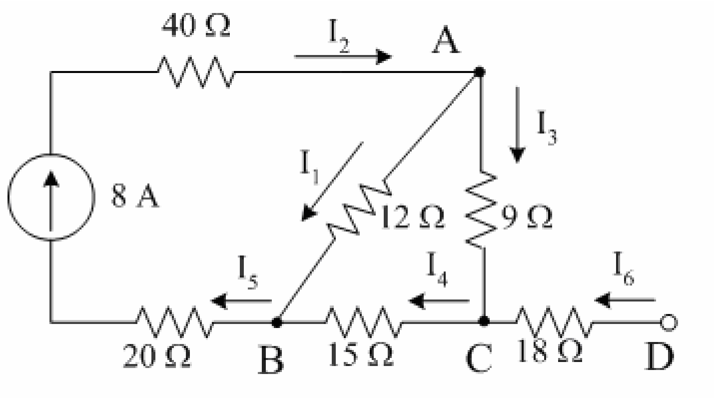
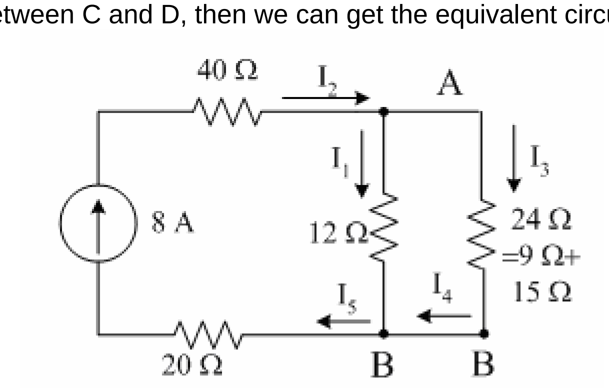
Problem 2 (10 points)

Determine the numeric values of the indicated parameters for the circuits shown below.

$V_{DB}=V_D-V_B$, the voltage of node D with respect to node B	40 V
I_1, the current through the 12 Ω resistor (note the indicated direction)	16/3=5.33 A
$V_{AC}=V_A-V_C$, the voltage of node A with respect to node C	24 V



SOLUTIONS:
I. By inspection of the current sources
$I_2=I_S$=8 Ampere
$I_5=I_S$=8 Ampere
II. Connection equations come from KCL and KVL
Remember that I said that we always use KCL when we see current sources. I will always use +in notation for the currents at all nodes.
At the node A: $+I_2-I_1-I_3=0$ Therefore $I_2= I_1+I_3=8$ Ampere
At the node B: $+I_1+I_4-I_5=0$ Therefore $I_5= I_1+I_4=8$ Ampere
At the node D, which is floating, therefore there is no current from C to D, that is $I_6=0$. Since there is no current through the resistor between C and D, then $V_{DC}=V_D-_{VC}=I_6*18\Omega=0*18\Omega=0$ Volt. That means, $V_D=V_C$, then $V_{DB}=V_D-V_B=V_C-V_B=V_{CB}$
At the node C, $+I_3+I_6-I_4=0$. Therefore, $I_3=I_4$
III. Current division and circuit reduction
If we ignore the resistor between C and D, then we can get the equivalent circuit as follows:



Using current division equations,

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$I_1 = \frac{G_1}{G_1 + G_2} I_2$ and $I_3 = \frac{G_2}{G_1 + G_2} I_2$

So $I_1 = \frac{G_1}{G_1 + G_2} I_2 = \frac{\frac{1}{12}}{\frac{1}{12} + \frac{1}{24}} \cdot 8 = \frac{16}{3}$ Amperes and $I_3 = \frac{G_2}{G_1 + G_2} I_2 = \frac{\frac{1}{24}}{\frac{1}{12} + \frac{1}{24}} = \frac{8}{3}$ Amperes;

Actually, we can simplify a little bit here by

$$I_1 = \frac{G_1}{G_1 + G_2} I_2 = \frac{\frac{1}{R_1}}{\frac{1}{R_1} + \frac{1}{R_2}} \cdot I_2 = \frac{R_2}{R_1 + R_2} \cdot I_2 = \frac{24}{12 + 24} \cdot 8 = \frac{16}{3}$$ Amperes;

And $I_3 = I_2 - I_1 = 8 - \frac{16}{3} = \frac{8}{3}$ Amperes;

We have known the value of I_3, then we can calculate V_{DB}.

As stated above, $V_{DB} = V_{CB} = I_3 \cdot 15\Omega = \frac{8}{3} \cdot 15 = 40$ Volts

Likewise, $V_{AC} = I_3 \cdot 9\Omega = \frac{8}{3} \cdot 9 = 24$ Volts