MAE140 HW1 Solutions

1.16)

i(t) = 20 sin(1000t) mA , v(t) = 100 sin(1000t) V

Power = iv = (.02*100)$\sin^2$(1000t)Watts

Max = 2 Watts

Min = 0 Watts

1.21)

a) P = 11V * -1.1A = -12.1 Watts from A to B = **12.1 Watts from B to A**

b) P = 80V * .02 A = **1.6 Watts from A to B**

c) P = -120V * -.012 A = **1.44 Watts from A to B**

d) P = -1.5V * -0.0006 A = **0.0009 Watts = 900μW from A to B**

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1.23)

Method 1)

Power is Balanced (for convenience flip arrow on i1 and label it +2A)

$P_1 = 20V*2A = 40W$ (Sourcing Power)

$P_1-P_2-P_3-P_4-P_5-P_6 = 0$ (All other elements are absorbing power)

$P_4 = 40-20-10-2.5-2.5$

P_4 = 5 Watts Absorbing (Absorbing because i_4 is >0 from v4+ to v4-)

Method 2)

$P_2 = 20W = iv = 2A*V \rightarrow v_2 = 10V$

$P_{5,6}$ in parallel absorb 5 Watts @ $1A \rightarrow v_{5,6} = 5V$

$v_4 = v_2-v_{5,6} = 5$ V

$i_4 = 1A$ (given)

$P_4 = 5V*1A =$ **5W Absorbing**

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2.3)

Conductance = 1mS = $1*10^{-3}$ S

Resistance = 1/Conductance = 1000Ω = 1k Ω

I = V/R = 9V/1k Ω = .009A = 9mA

2.7)

10 k Ω with P_{max} = 1/8 W

$P_{max} = (V_{max})^2/R \rightarrow V_{max} = \sqrt{\frac{10k\Omega W}{8}} = 35.36V$

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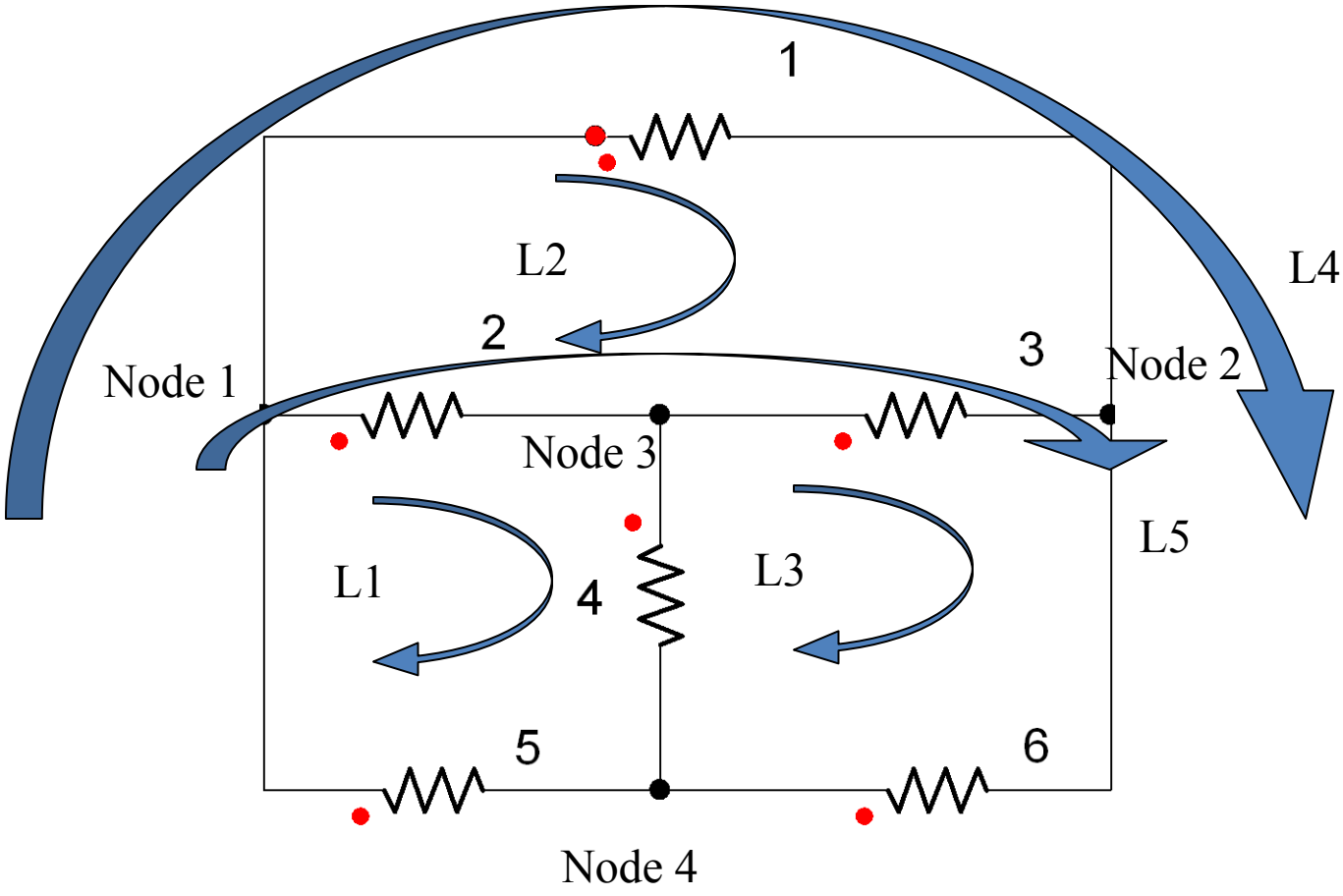
2.13)

Note the circuit can be re-drawn to make it easier to analyze



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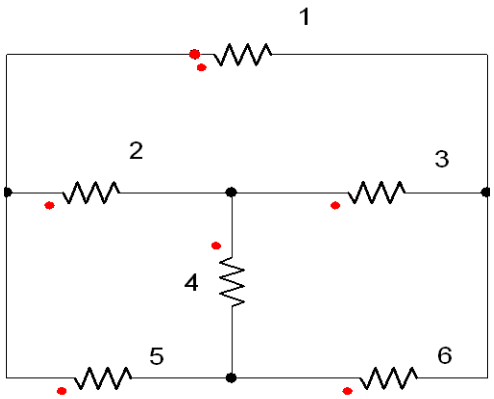
2.13) Continued

B) No elements are in series or parallel



C) KVL

$v_2-v_3-v_6-v_5 = 0$

$v_1+v_3-v_2 = 0$

$v_3-v_4+v_6 = 0$

$v_2-v_4-v_5 = 0$

$v_1-v_6-v_5 = 0$

KCL

$i_1+i_2+i_5 = 0$

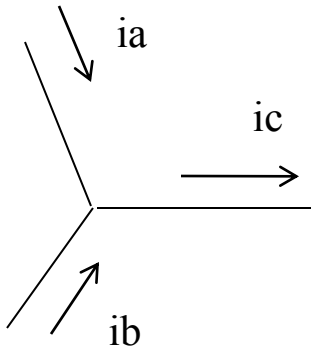
$i_2+i_4+i_3 = 0$

$i_1-i_3+i_6 = 0$

$i_5-i_4-i_6 = 0$

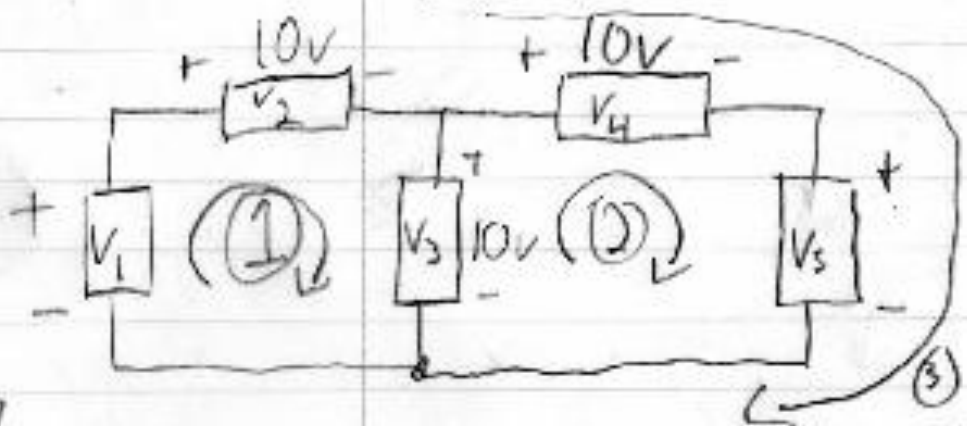
This is more equations than you will actually need to solve the circuit

If you are having trouble with determining the signs, remember KCL is just saying charge is **conserved**! All current entering a node exits the node.



ic = ia + ib

Problem 2-16



Note See Slide 16 of Course Slides

Loop 1
KVL Gives: $-V_1 + V_2 + V_3 = 0 \Rightarrow \boxed{V_1 = 20 \text{ Volts}}$

Loop 2:
KVL Gives: $-V_3 + V_4 + V_5 = 0 \Rightarrow \boxed{V_5 = V_3 - V_4 = 0 \text{ Volts}}$

Use as a Check (optional)

Loop 3
KVL Gives: $-V_1 + V_2 + V_4 + V_5 = 0$

$-20 + 10 + 10 + 0 = 0$ ✓

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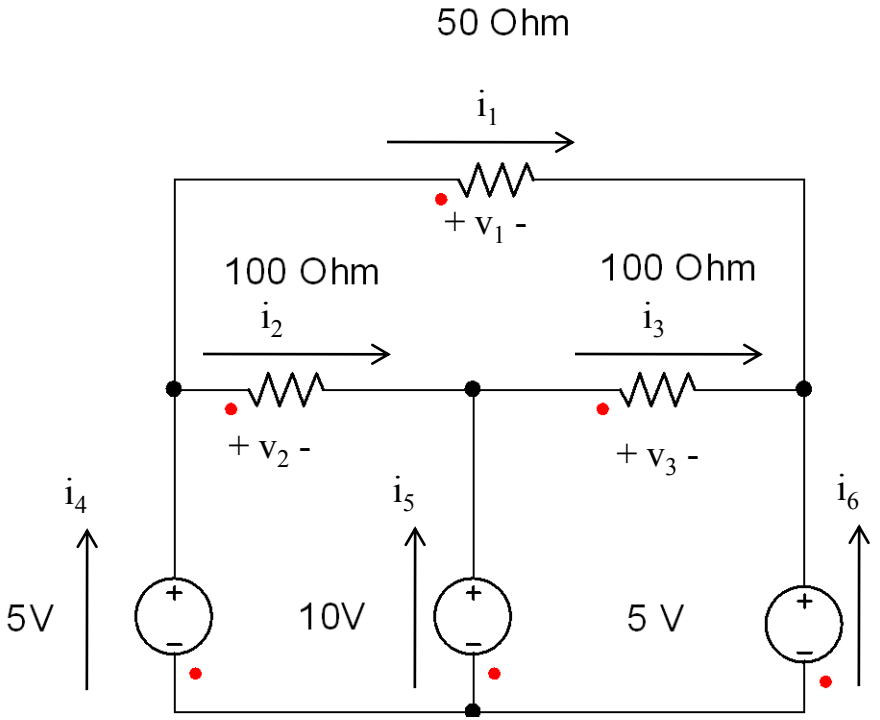
2.22)

A:



B: 1) v1-v2-v3=0

2) v2-5V+10V = 0

3) v3-10V+5V = 0

$$\begin{bmatrix} 1 & -1 & -1 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} = \begin{bmatrix} 0 \\ -5 \\ 5 \end{bmatrix} \rightarrow \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} = \begin{bmatrix} 0 \\ -5 \\ 5 \end{bmatrix}$$

*The fact that b = x is a coincidence! (It means 1 is an eigenvalue)

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2.22) continued

c: i1 = v1/50Ω = 0A

i2 = v2/100 Ω = -50mA

i3 = v3/100 Ω = 50mA

d:

i4 = i2+i1 = -50mA

i5 = i3-i2 = 100mA

i6 = -i3-i1 = -50mA

CHECK! Sum All Currents: Should Equal Zero

0 + -50 + 50 -50 +100 – 50 = 0 ☑

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2.29)

a) 100 + (200 | | 50) + 50 = 100 + (200*50)/(200+50) + 50 = **190 Ω**

b) 100 + 50 = **150 Ω**

2.34)

Remember, an **ideal** current source outputs the stated current no matter what! (Infinite power), so 5 Ω resistor does nothing when looking at the voltage from A to B because 5 A always goes through R_{AB} Therefore, V_{AB} = 50V

For completeness, look at the Thevenin equivalent

V_{oc} = 50V, I_{sc} = 5A, $R_t = V_{oc} / I_{sc}$ =10 Ω