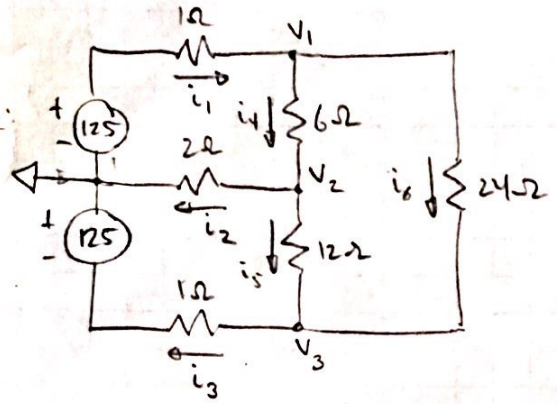
ENGR 221 HW #4 | Due 4/10/20 | Sean Lai

CH4 #1s : 15, 17, 26, 30, 34, 41, 52, 53, 56

4.15 :

Given :



Find : a) using NVA, find $i_1 - i_6$

b) show $P_s = P_s$ source power = dissipated power

Solution :

$$V_1: \quad \frac{V_1 - 125}{1} + \frac{V_1 - V_2}{6} + \frac{V_1 - V_3}{24} = 0$$

$$V_2: \quad \frac{V_2 - V_1}{6} + \frac{V_2}{2} + \frac{V_2 - V_3}{12} = 0$$

$$V_3: \quad \frac{V_3 - V_1}{24} + \frac{V_3 - V_2}{12} + \frac{V_3 + 125}{1} = 0$$

$$\rightarrow \begin{aligned} V_1\left(1+\tfrac{1}{6}+\tfrac{1}{24}\right) + V_2\left(-\tfrac{1}{6}\right) + V_3\left(-\tfrac{1}{24}\right) &= 125 \\ V_1\left(-\tfrac{1}{6}\right) + V_2\left(\tfrac{1}{6}+\tfrac{1}{12}+\tfrac{1}{2}\right) + V_3\left(-\tfrac{1}{12}\right) &= 0 \\ V_1\left(-\tfrac{1}{24}\right) + V_2\left(-\tfrac{1}{12}\right) + V_3\left(\tfrac{1}{24}+\tfrac{1}{12}+1\right) &= -125 \end{aligned}$$

$V_1 = 101.2433$

$V_2 = 10.6572$

$V_3 = -106.5719$

a) $i_1 = \frac{125 - V_1}{1} \rightarrow i_1 = 23.757\,A$

$i_2 = \frac{V_2}{2} \rightarrow i_2 = 5.329\,A$

$i_3 = \frac{V_3 + 125}{1} \rightarrow i_3 = 18.428\,A$

$i_4 = \frac{V_1 - V_2}{6} \rightarrow i_4 = 15.098\,A$

$i_5 = \frac{V_2 - V_3}{12} \rightarrow i_5 = 9.769\,A$

$i_6 = \frac{V_1 - V_3}{24} \rightarrow i_6 = 8.659\,A$

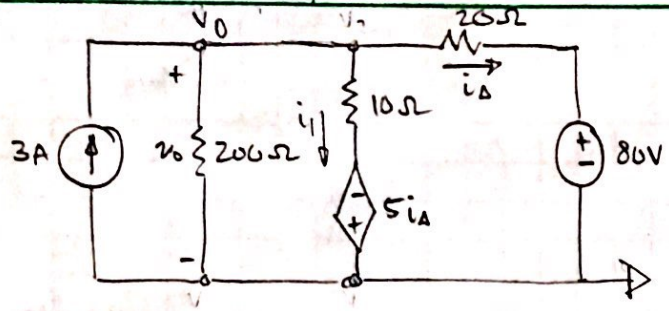
b) $P_s = |i_1 \cdot 125 + i_3 \cdot 125| = 5273\,W$

$P_D = i_1^2(1) + i_2^2(2) + i_3^2(1) + i_4^2(6) + i_5^2(12) + i_6^2(24) = 5273\,W$ ✓

$\boxed{P_s = P_D}$

4.17:

Given:



Find: a) use NVA to find V_o
b) power absorbed by dependent source
c) total power developed by independent sources

Solution:

a) V_0: $-3 + \frac{V_1}{200} + \frac{V_1 + 5i_\Delta}{10} + \underbrace{\frac{V_1 - 80}{20}}_{i_\Delta} = 0$

$$\rightarrow V_1\left(\frac{1}{200} + \frac{1}{10} + \frac{1}{20}\right) + \frac{1}{2}\left(\frac{V_1 - 80}{20}\right) = 3 + 4$$

$$V_1\left(\frac{1}{200} + \frac{1}{10} + \frac{1}{20} + \frac{1}{40}\right) = 3 + 4 + 2$$

$$\boxed{V_0 = 50V}$$

b) $i_1 = \frac{V_0 + 5i_\Delta}{10}$, $i_\Delta = \frac{V_1 - 80}{20}$

$i_\Delta = -1.5A$

$i_1 = 4.25\,A$

$P_{DS} = 5i_\Delta \cdot i_1$

$$\boxed{P_{DS} = 31.875\,W}$$

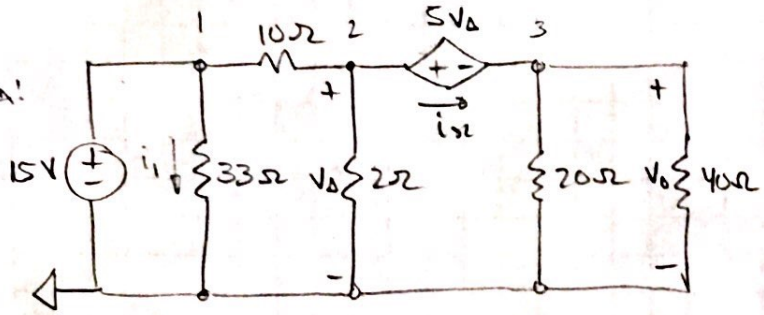
c) $P_T = P_{CS} + P_{VS}$

$= V_0 \cdot 3A + 80V \cdot i_\Delta$

$$\boxed{P_T = 270W}$$

4.26:

Given:



Find: V_o

Solution:

1: $V_1 = 15V$, $i_1 = \frac{V_1}{33} = 0.455A$

2: $\frac{V_2 - V_1}{10} + \frac{V_2}{2} + i_x = 0$, $V_2 = V_\Delta$

3: $-i_x + \frac{V_3}{20} + \frac{V_3}{40} = 0$, $V_3 = V_o$

from given, $i_x = 5V_\Delta$

$$\rightarrow \frac{V_\Delta - 15}{10} + \frac{V_\Delta}{2} + 5V_\Delta = 0$$
$$-5V_\Delta + \frac{V_o}{20} + \frac{V_o}{40} = 0$$

$$\rightarrow V_\Delta\left(\frac{1}{10} + \frac{1}{2}\right) + V_o\left(\frac{1}{20} + \frac{1}{40}\right) = \frac{15}{10}$$

$$V_\Delta - V_o = 5V_\Delta$$
$$\rightarrow V_o = -4V_\Delta$$

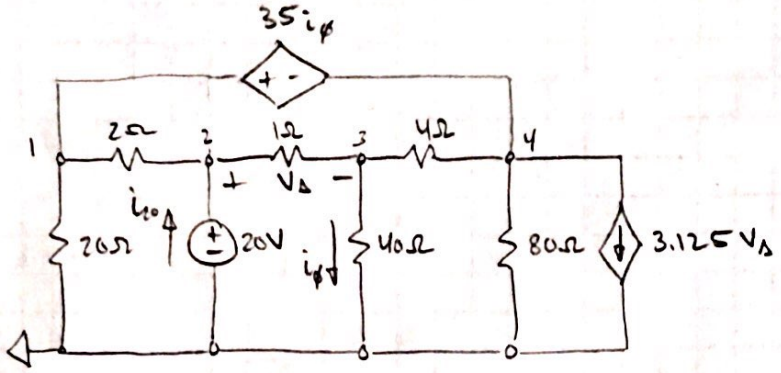
$$\rightarrow V_\Delta\left(\frac{1}{10} + \frac{1}{2} - \frac{1}{5} - \frac{1}{10}\right) = \frac{15}{10}$$

$$V_\Delta = +5V$$

$$\boxed{V_o = -20V}$$

4.30:

Given:



Find: P_{20V}

Solution:

1-4 supernode: $\frac{V_1}{20} + \frac{V_1 - V_2}{2} + \frac{V_4 - V_3}{4} + \frac{V_4}{80} + 3.125 V_\Delta = 0$, $V_\Delta = V_2 - V_3$

$V_1 = V_4 + 35 i_\phi$

2: $V_2 = 20$

3: $\frac{V_3 - V_2}{1} + \underbrace{\frac{V_3}{40}}_{i_\phi} + \frac{V_3 - V_4}{4} = 0$

$\rightarrow V_1 = V_4 + 35\left(\frac{V_3}{40}\right)$

$\rightarrow \frac{V_4 + \frac{7}{8}V_3}{20} + \frac{V_4 + \frac{7}{8}V_3 - 20}{2} + \frac{V_4 - V_3}{4} + \frac{V_4}{80} + 3.125(20 - V_3) = 0$

$V_3 - 20 + \frac{V_3}{40} + \frac{V_3 - V_4}{4} = 0$

$V_4\left(\frac{1}{20} + \frac{1}{2} + \frac{1}{4} + \frac{1}{80}\right) + V_3\left(\frac{7}{160} + \frac{7}{16} - \frac{1}{4} - 3.125\right) = 10 - 20(3.125)$

$V_4\left(-\frac{1}{4}\right) + V_3\left(1 + \frac{1}{40} + \frac{1}{4}\right) = 20$

$\rightarrow V_4 = -29$

$V_3 = 10$

$V_\Delta = V_2 - V_3$

$V_\Delta = -10V$

$V_1 = V_4 + 35\left(\frac{V_3}{40}\right)$

$V_1 = -20.025$

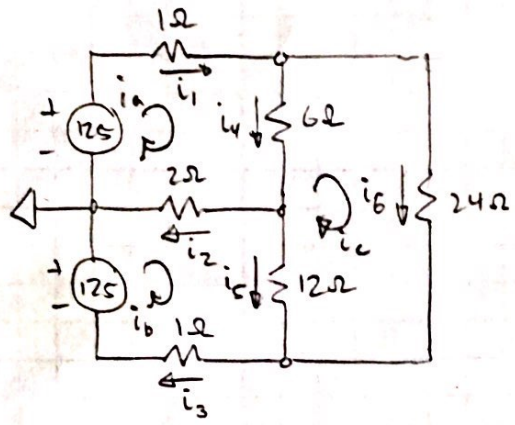
$\rightarrow \frac{V_2 - V_1}{2} + \frac{V_2 - V_3}{1} - i_{20} = 0$

$i_{20} = 30.0125$

$\boxed{P_{20V} = i_{20} \cdot 20 = 602.5W}$

4.34:

Given:



Find: a) Use MCA to find $i_1 - i_6$
b) show $P_s = P_R$

Solution:

a: $-125 + i_a + 6(i_a - i_c) + 2(i_a - i_b) = 0$ $\quad i_1 = i_a$

b: $-125 + 2(i_b - i_a) + 12(i_b - i_c) + i_b = 0$ $\quad i_3 = i_b$

c: $24i_c + 12(i_c - i_b) + 6(i_c - i_a) = 0$ $\quad i_6 = i_c$

$$\rightarrow \quad \begin{aligned} i_a(1+6+2) + i_b(-2) + i_c(-6) &= -125 \\ i_a(-2) + i_b(2+12+1) + i_c(-12) &= -125 \\ i_a(-6) + i_b(-12) + i_c(24+12+6) &= 0 \end{aligned}$$

$i_a = i_1 = 23.77\ A$
$i_b = i_3 = 18.43\ A$
$i_c = i_6 = 8.66\ A$

$i_4 = i_a - i_c = 15.11\ A$
$i_2 = i_a - i_b = 5.34\ A$
$i_5 = i_b - i_c = 9.77\ A$

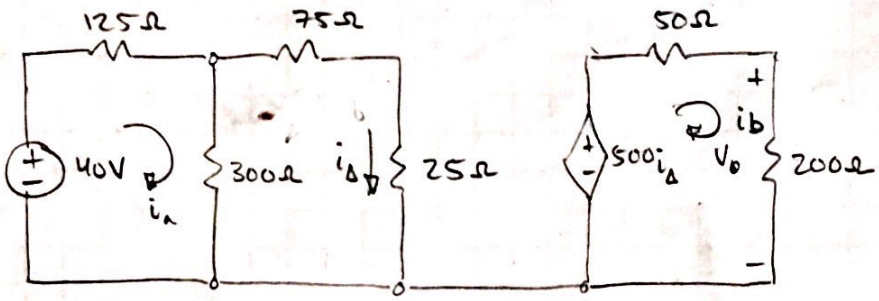
a) $\rightarrow$

$i_1 = 23.77\ A$
$i_2 = 5.34\ A$
$i_3 = 18.43\ A$
$i_4 = 15.11\ A$
$i_5 = 9.77\ A$
$i_6 = 8.66\ A$

b) see problem 4.15 for power calculations

4.41:

Given:



Find: a) Use MCA to find V_o
b) P_D, dependent source power

Solution:

a: $-40 + 125i_a + 300(i_a - i_\Delta) = 0$
b: $75i_\Delta + 25i_\Delta + 300(i_\Delta - i_a) = 0$
c: $50i_b + 200i_b - 500i_\Delta = 0$

$$\begin{aligned} i_a(125+300) + i_\Delta(-300) + i_b(0) &= 40 \\ \rightarrow\quad i_a(-300) + i_\Delta(75+25+300) + i_b(0) &= 0 \\ i_a(0) + i_\Delta(-500) + i_b(50+200) &= 0 \end{aligned}$$

$i_a = 0.2\,A$
$i_\Delta = 0.15\,A$
$i_b = 0.3A$

$V_o = i_b \cdot 200\Omega$

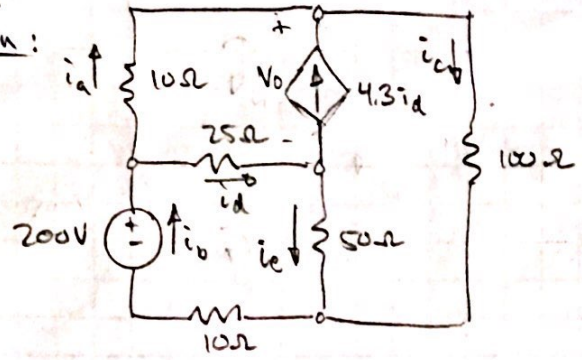
a) $\boxed{V_o = 60V}$

b) $P_D = 500i_\Delta \cdot i_b$

$\boxed{P_D = 22.5W}$

4.52:

Given:



Find: a) Use MCA to find $i_a - i_e$
b) Show $P_s = P_D$, power from sources equals power dissipated

Solution:

a) $10i_a + 100i_c + 50(i_c - i_b) + 25(i_a - i_b) = 0$

$-200 + 25(i_b - i_a) + 50(i_b - i_c) + 10i_b = 0$

$i_c - i_a = 4.3i_d$, $i_a + i_d = i_b$

$i_d = i_b - i_a$

$\rightarrow i_c - i_a = 4.3(i_b - i_a)$

$\rightarrow$ $i_a(10+25) + i_b(-50-25) + i_c(100+50) = 0$

$i_a(-25) + i_b(25+50+10) + i_c(-50) = 200$

$i_a(-3.3) + i_b(4.3) + i_c(-1) = 0$

$i_a = 5.7A$
$i_b = 4.6A$
$i_c = 0.97A$
$i_d = -1.1A$
$i_e = 3.63A$

b) MCA: $10i_a + V_o + 25(i_a - i_b) = 0$

$V_o = -84.5$

$P_D = i_a^2(10) + i_c^2(100) + i_b^2(10) + i_d^2(25) + i_e^2(50)$

$P_D = 1319.7W$

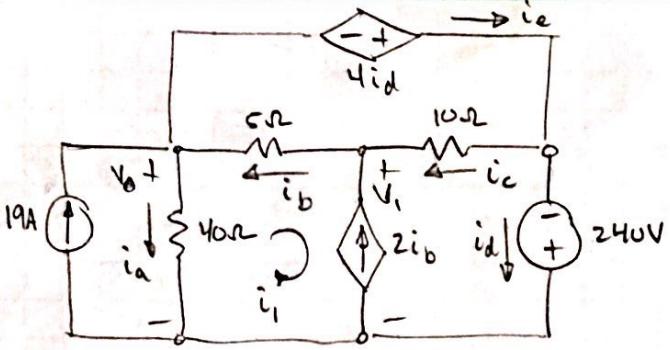
$P_s = -200i_b + -84.5(i_a - i_c)$

$P_s = 1319.7W$

$P_D = P_s$ ✓

4.53:

Given:



Find: a) $i_a - i_e$

b) Show that $P_{generated} = P_{dissipated}$

Solution:

a) $10(i_e - i_d) + 5(i_e - i_1) - 4i_d = 0$

$-240 + 40(i_1 - 19) + 5(i_1 - i_e) + 10(i_d - i_e) = 0$

$i_d - i_1 = 2i_b$, $i_b = i_e - i_1$ $\rightarrow$ $2i_e - i_1 - i_d = 0$

$$\rightarrow \begin{array}{llll} i_1(-5) & + i_d(-10-4) & + i_e(10+5) & = 0 \\ i_1(40+5) & + i_d(10) & + i_e(-5-10) & = 240 + 40(19) \\ i_1(-1) & + i_d(-1) & + i_e(2) & = 0 \end{array}$$

$i_1 = 26\ A$
$i_d = 10\ A$
$i_e = 18\ A$
$i_a = 19 - i_1 = -7A$
$i_b = i_e - i_1 = -8A$
$i_c = i_e - i_d = 8A$

$\rightarrow$

$i_a = -7A$
$i_b = -8A$
$i_c = 8A$
$i_d = 10A$
$i_e = 18A$

b) $V_o = i_a \cdot 40\Omega = -280V$

$-V_1 - i_c \cdot 10 - 240 = 0$

$V_1 = -320V$

$P_{19A} = -19(-280) = +5320W$
$P_{2i_b} = -2i_b(-320) = -5120$
$P_{240} = -i_d(240) = -2400W$
$P_{4id} = -i_e(4i_d) = -770$

$P_{gen} = -8240\ W$

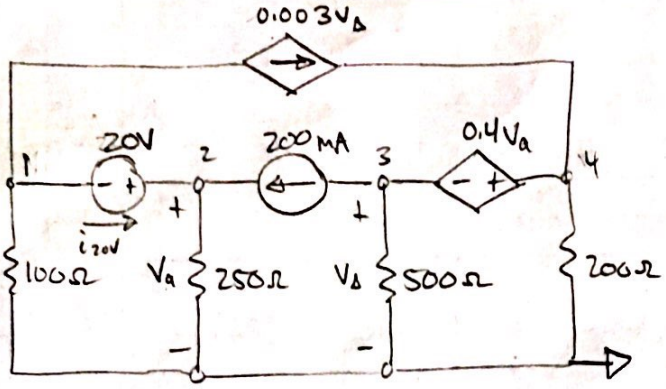
$P_{diss} = +5320 + i_a^2(40) + i_b^2(5) + i_c^2(10)$

$P_{diss} = +8240$

$$|P_{gen}| = |P_{diss}|$$

4.56:

Given:



Find: a) Would I use NVA or MCA to find P_{20V}? Explain
b) Use method from a) to find P_{20V}.

Solution:

a) I would use NVA because I can create a supernode across 0.4V_a dependent source, and 1 and 2 are connected by an independent source.

b) NVA: $V_2 - V_1 = 20V \rightarrow V_2 = V_1 + 20V$

$V_4 - V_3 = 0.4V_2 \rightarrow V_4 = 0.4V_2 + V_3 = 0.4(V_1 + 20) + V_3$

$$\frac{V_1}{100} + 0.003V_3 + \frac{V_2}{250} - 0.2 = 0$$

$$\frac{V_4}{200} - 0.003V_3 + \frac{V_3}{500} + 0.2 = 0$$

$$\frac{V_1}{100} + 0.003V_3 + \frac{V_1 + 20}{250} - 0.2 = 0$$

$$\frac{0.4V_1 + 8 + V_3}{200} - 0.003V_3 + \frac{V_3}{500} + 0.2 = 0$$

$$V_1\left(\frac{1}{100} + \frac{1}{250}\right) + V_3(0.003) = 0.2 - 0.08$$

$$V_1(0.002) + V_3\left(\frac{1}{200} - 0.003 + \frac{1}{500}\right) = -0.2 - 0.04$$

$V_1 = 24V$

$V_3 = -72V$

$V_2 = 44V$

$V_4 = -54.4$

$$i_2 = \frac{V_2}{250} = 0.176A$$

$i_{20V} = i_2 - 0.2$

$i_{20V} = -0.024A$

$P_{20V} = (-0.024) \cdot 20V$

$P_{20V} = +0.48$

$P_{20V} = 0.48W$, absorbed