HW4: Set #1

Daren Lin

1) All circuits have nodes, but not all circuits have two currents.
It can use less equations

2) $\frac{V_1-144}{4}+\frac{V_1}{10}+\frac{V_1-V_2}{80}=0$

$V_1\left(\frac{1}{4}+\frac{1}{10}+\frac{1}{80}\right)+V_2\left(-\frac{1}{80}\right)=\frac{144}{4}$

$29V_1-V_2=2880$

$\frac{V_2-V_1}{80}+3+\frac{V_2}{5}=0$

$V_1\left(-\frac{1}{80}\right)+V_2\left(\frac{1}{80}+\frac{1}{5}\right)=3$

$-V_1+17V_2=240$

$17(29V_1-V_2)=17(2880)$

$\boxed{V_1=100\,V}$

$-V_1+17V_2=240$

$\boxed{V_2=20\,V}$

3) a) $\frac{V_1 - V_2}{1250} + \frac{V_1}{1000} + 20 \cdot 10^{-3} = 0$

$2.25V_1 - V_2 = -25$

$\frac{V_2 - V_1}{1250} + \frac{V_2}{4000} + \frac{V_2}{2000} + \frac{V_2 + 2500i}{200} = 0$

$i = \frac{V_2 - V_1}{1250}$

$26.2V_2 - 3.2V_1 - 50000i = 0$

$-13.8V_2 + 36.8V_1 = 0$

$V_1 = 60 \quad V_2 = 160$

$i = \frac{160 - 60}{1250} = 0.08\ A$

$P_{20mA} = V_1 \cdot 20 \cdot 10^{-3} = 1.2\ W$

$P_{2500i} = 2500i \times i = 2500(0.08) \cdot \left(\frac{160 - 250i(0.08)}{200}\right)$

$= \boxed{-40W}$

b) $\Sigma P = \frac{V_1^2}{1000} + 1250i^2 + \frac{V_2^2}{4000} + \frac{V_2^2}{2000} + i^2 200$

$= 28.8\ W$

$38.8 + 1.2 = \boxed{40W}$

4) $7 + \frac{V_0}{3} + \frac{V_0 - V_1}{1} = 0 \qquad V_1 = \frac{4V_0 + 21}{3}$

$V_x = V_1 - 4 \qquad \frac{V_1 - 4}{2} + \frac{V_1 - V_0}{1} - 2V_x = 0$

$-V_1 - 2V_0 + 12 = 0$

$-V_1 + 2V_0 + 12 = 0$ $\quad -\left(\frac{4V_0+24}{3}\right) - 2V_0 + 12 = 0$

$-4V_0 - 21 - 6V_0 + 36 = 0$

$\boxed{V_0 = 1.5\ V}$

5) $V_1 - V_2 = 35 i_0$

$V_1 = 35 i_0 + V_2$ $\quad i = \frac{20 + V_\Delta}{40}$

$-\frac{V_\Delta}{1} + \frac{20 - V_\Delta}{40} + \frac{20 - V_\Delta - V_2}{4} = 0$

$\frac{V_1}{20} + \frac{V_1 - 20}{2} + \frac{V_2}{80} + \frac{V_2 - (20 - V_\Delta)}{4} + 3.125 V_\Delta = 0$

$\frac{35 i_0 + V_2}{20} + \frac{35 i_0 + V_2 - 20}{2} + \frac{V_2}{80} + \frac{V_2 - (20 - V_\Delta)}{4} + 3.125 V_\Delta = 0$

$V_2 = -29\ V \quad V_\Delta = 10V$

$V_1 = -20.25\ V \quad i_0 = 0.25\ A$

$P_{20V} = V_S I_S$

$I_S = \frac{20 - V_1}{2} + \frac{V_\Delta}{1} = 30.125\ A$

$P = 20 \cdot 30.125 = \boxed{602.5\ W}$

6) $53 i_\Delta + 5(i_1 - i_3) + 3(i_1 - i_2) = 0$

$8 i_1 - 3 i_2 - 5 i_3 + 53 i_\Delta = 0$

$30 i_2 - 3 i_1 - 20 i_3 = 30$

$27 i_3 - 20 i_2 - 5 i_1 = 30$

$i_\Delta = i_2 - i_3$

$80i_1 + 50i_2 - 58i_3 = 0$

$i_1 = 110\,A \quad i_2 = 52\,A \quad i_3 = 60\,A$

$\Delta i = -8\,A$

$P = 53 i_\Delta \cdot i_1 = 53(-8) \cdot 110 = \boxed{-46640\,W}$

7) a) $45i_1 - 5i_e - V_{2i_b} = 760$

$10i_d - 10i_e + V_{2i_b} = 240$

$-5i_1 - 14i_d + 15i_e = 0$

$2i_b = i_d - i_1 \quad i_b = i_e - i_1$

$i_1 + i_d - 2i_e = 0$

$V_{2i_b} = 45i_1 - 5i_e - 760$

$45i_1 + 10i_d - 15i_e = 1000$

$\boxed{i_1 = 26\,A} \quad \boxed{i_d = 10\,A} \quad \boxed{i_e = 18\,A}$

$\boxed{i_\Delta = -7\,A} \quad \boxed{i_b = -8\,A} \quad \boxed{i_c = 8\,A}$

b) $P_{240V} = 240 \cdot -10 = -2400\,W$

$P_{4i_d} = 4(10) \cdot -18 = -720\,W$

$P_{2i_b} = 2(-8)(45(26) - 5(18) - 760) = -5120\,W$

$V_{\text{dep}} + 40 i_\Delta = 280\,V$

$P_{15A} = 280 \cdot 19 = 5320\,W$

$P_{dev} = -5120 - 720 - 2400 = -8240\ W$

$P_{diss} = 2170\ W + 5320 = 8240$

$P_{dev} = P_{diss} = 8240$

8) a) Node analysis as there are less constraints

b) $I_c = \frac{V_A}{250}$ $I_4 = \frac{V_1}{100}$ $I_1 = 200mA - I_c$

$V_1 = V_a - 20$

$I_1 = I_4 + 0.003 V_A$

$I_2 = \frac{V_A}{500}$

$V_a = 44\ V$ $V_A = -72\ V$

$I_1 = 200mA - \frac{V_1}{250} = 0.2 - \frac{V_{44}}{250} = 0.024\ A$

$20 \cdot 0.024 = 480\ mW$

9) a) $i_1 = \frac{120}{240k} = 3mA$ $R_1 = \frac{(40k)(60k)}{100k} = 24k\Omega$

$V_1 = (3)(24) = 72V$ $R_2 = 24k + 4k + 2k = 30k\Omega$

$i_2 = \frac{72}{30} = 2.4\ mA$ $R_3 = \frac{(30)(90)}{120} = 22.5k\Omega$

$i_3 = 8.4 - 24 = 6mA$ $V_3 = 6 \cdot 22.5 = 135\ V$

$i_0 = \frac{135}{40k} = -3.375mA$

6) $V_1 = (-3.375m)(2.5k + 15k) = -59.0625\ V$

$i_z = \frac{V_1}{90} = \frac{-59.0625}{90k} = -0.6563\ mA$

$i_x = 8.4 + i_z - 3.375 = 4.3687\ mA$

$V_2 = i_x(4+2) + V_1 = -32.8503\ V$

$i_w = \frac{V_2}{60} = -0.5475\ mA$

$i_y = i_w + i_x = 3.8212\ mA$

$P = (120)(i_y) = \boxed{0.4585\ W}$

10) a) $V_1 = 2 \cdot 6 = 12\ V$

$V_2 = (1)(5) = 5\ V$

$I_1 = \left(\frac{17}{17}\right) = 1\ A \qquad I_2 = \left(\frac{34}{17}\right) = 2\ A$

$\left(\frac{1}{17} + \frac{1}{17}\right)^{-1} = 8.5\ \Omega \qquad i_6 = -\left(\frac{8.5}{10}\right) = \boxed{-0.85\ A}$

b) $6(i_a - 2) + 6i_a + 5(i_a - 1) + 17(i_a - i_b) - 34 = 0$

$i_a = \frac{51 + 17i_b}{34}$

$-17i_b + 18.5i_b = -34$

$i_b = -\frac{281}{340} = \boxed{i_b = -0.85\ A}$