HW 4 set 2

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1) 4.63

a) $V = IR = 40\ V$

$R = 40 + 4 + 6 = 50\ \Omega$

$V = 520 - 40 = 480\ V$

$V_o = 480 \cdot \frac{250}{50+250} = 400\ V$

$I_o = \frac{400}{250} = 1.6\ A$

b) $P_{520V} = 520 \cdot 1.6 = \boxed{832\ W}$

c) $P_{1A} = 40 \cdot (-1.6) = \boxed{-64\ W}$

d) $R_{eq} = 250 + 50 = 300\ \Omega$

$P_{4\Omega} = (1.6)^2 \cdot 300 = \boxed{768\ W}$

2) 4.17

$V = (3)(150) = 450\ V$

$45 I_1 - 40 I_2 = 300$

$-40 I_1 + 200 I_2 = -450$

$200 I_1 = 1050$

$I_1 = 5.25\ A \qquad I_2 = -1.2\ A$

$V_{th} = 10(-1.2) + 8(5.25) = 30\ V$

$$R_{th} = \frac{50(150)}{50+450} = 15\,\Omega$$

3) 6.74

$$\frac{V_1 - 100}{2500} + \frac{V_1}{625} - 10^{-3} V_a = 0$$

$$\frac{V_a - 5000i}{4000} + \frac{V_1}{6000} = 0$$

$$\left(\frac{1}{2400}\right) V_1 = \frac{5}{4} i$$

$$i = -\frac{1}{2500} V_1 + \frac{1}{25}$$

$V_1 = -50\,V \quad V_a = 60\,V \quad i = 0.02\,A$

$$\boxed{V_{th} = 60\,V}$$

$$i_{sc} = \frac{5000i}{4000} = \frac{5000 \frac{100}{2500 \cdot 625}}{4000} = 0.04\,A$$

$$R_{Th} = \frac{V_{th}}{i_{sc}} = \frac{60}{0.04} = 1.5k\Omega$$

4) $$\frac{V - 250 i_x}{500} - 1.5 i_x + \frac{V}{750} - 1 = 0$$

$$i_x = \frac{V}{750}$$

$$3V - V - 3V + 2V = 1500 \qquad V = 1500\,V$$

$$i_x = 2\,A$$

$$R_N = \frac{1500V}{1\,A} = 1500\,\Omega$$

5) (2)

a) $\dfrac{(5000)\left(1600+\dfrac{2400\cdot 4800}{2400+4800}+1800\right)}{5000+1600+\dfrac{(2400)4400}{2400+4800}+1800} = 2500\,\Omega$

$R_o = R_{th} = 2500\,\Omega$

b) $7200I_1 - 4800I_2 = 60$

$4800I_2 - 4800I_1 + 8400I_3 = 0$

$I_2 - I_3 = 0.015$

$I_1 = 19.4\text{mA}$ $I_2 = 16.6\text{mA}$ $I_3 = 1.6\text{mA}$

$V_{Th} = 5000(i_3) = 8\text{V}$

$P_{max} = \dfrac{8^2}{4(2500)} = 6.4\text{mW}$

c) $P = \left(\dfrac{V_{th}}{R_o + R_{th}}\right)^2 R_o = \left(\dfrac{8}{2700+2500}\right)^2 (2700)$

$= \boxed{6.391\text{mW}}$

6) (6) a) $R_{th} = 1866.67\,\Omega$

b) $i_o = \dfrac{60}{2} = 30\text{mA}$

$P = 30^2 \cdot 1866.67 = 1.68\text{W}$

c) $I_1 = \frac{V_1}{2k}$ $I_2 = \frac{V_1 - V_2}{2}$ $i_2 = \frac{280 - V_1}{2}$

$224 = 28V_1 - V_2$ $I_3 = \frac{V_2}{5.6}$

$I_0 = \frac{V_2}{1866.67}$

$i_A = \frac{280 - 100}{2} = 90\,mA$

$V_1 = 100\,V$ $V_2 = 56\,V$

$280 \cdot 90 \cdot 10^{-3} = 25.2\,W$

$0.2 \cdot i_2 (V_1 - V_2) = 0.2 \cdot 90 \cdot 10^{-3} (100 - 56) = 0.792\,W$

$P_T = 25.2 + 0.792 = 25.992\,W$

$P\% = \frac{1.68}{25.992} \cdot 100 = 6.46\%$

d) $R = 1800\,\Omega$

e) $i_2 = \frac{280 - V_1}{2} = \frac{280 - 99.63}{2} = 90.18\,mA$

$280 \cdot 90.14 \cdot 10^{-3} = 25.25\,W$

$0.2 \cdot 90.18 \cdot (99.63 - 54.98) = 0.805\,W$

$P_T = 25.25 \cdot 0.805 = 26.055\,W$

$P_{1800\Omega} = \frac{V^2}{1800} = 1.671\,W$

$\frac{1.671}{26.055} \cdot 100 = 6.32\%$

7) a0

a) $i_\Delta = -(i_2 + i_1)$

$-124 i_2 + 12 i_3 + 4 i_1 - 8 i_2 = 0$

$i_3 = -\frac{116 i_2 - 128 i_1}{12}$

$i_2 = -4.1\ A$

$i_1 = \frac{100 - 41.33 i_2}{57.33}$

$i_1 = \frac{100 + 169.4665}{57.33} = 4.7\ A$

$V_{th} = -i_\Delta(80) = (i_2 + i_1)(80)$

$V_{th} = (4.7 - 4.1)(80) = 48\ V$

$i_3 = \frac{2 i_2 - 1}{3}$ $\quad i_1 = \frac{300 - 8 i_2}{56}$

$i_2 = 2.5159$ $\quad i_1 = 4.9977$

$i_N = -4.9977 + 2.5159 = -7.5136$

$R_{th} = \frac{48}{7.5136} = 6.3884$

b) $V = (48)\left(\frac{6.3884}{2(6.3884)}\right) = 24$

$P_{max} = \frac{48^2}{6.3884} = 360.6537\ W$

c) $i_4 = \frac{80 i_1 - 6.3884}{86.3884}$

$i_3 = \frac{-13.1698 i_1 + 1.1698 i_2}{12}$ $\quad i_1 = \frac{1006.305 + i_2}{21.5261}$

$i_2 = -0.9771\ A \qquad i_1 = 4.9025$

$i_3 = -5.4659$

$P_V = 100 \cdot 4.9025 = 490.25\ W$

$\%P = \frac{360.6537}{490.25} \cdot 100 = 73.57\%$

d) R_0, close to 6.3864

5) 9.1)

a) $I_1 + I_2 + I_3 + I_4 + I_5 = 0$

$\frac{V_1}{16} + \frac{V_1 - 180}{20} + \frac{V_2}{10} - 0.1 V_\Delta + \frac{V_2 - 180}{10} = 0$

$V_\Delta = 2 \cdot I_5 = 2 \times \frac{V_1 - 180}{10}$

$V_1 = 5 V_\Delta = 180$

$V_1 = 80V \qquad V_\Delta = -20V$

$V_{Th} = 180 + V_\Delta = 160\ V$

$\frac{10 i_4 - 720}{16} + \frac{12 i_4 - 720 - 180}{20} + \frac{8 i_4 - 720}{10} - 0.1(-180)$

$+ (i_4 - 90) = 0$

$i_d = 10 \qquad I_{SC} = 10$

$$R_{Th} = \frac{160}{10} = 16\,\Omega$$

b) $I_o = \frac{160}{16+16} = 5$

$$P_{R_6} = I^2(16) = 25 \cdot 16 = 400\,W$$

c) $I_5 = \frac{V_2 - V_6}{8} = \frac{V_2 - 80}{8}$

$$\frac{V_1}{16} + \frac{V_1 - 180}{20} + \frac{V_2}{10} + 10 + (i_\phi - 90) + \frac{V_2 - 80}{20} = 0$$

$V_1 = 640\,V \quad V_2 = -280\,V$

$I_5 = -(I_2 + i_\Delta)$

$I_\Delta = \frac{-100}{2} = -50\,A$

$I_2 = \frac{640 - 180}{20} = 23\,A$

$P_{180V} = 180 \cdot 27 = 4860\,W$

9) a3

$-40 i_1 - 100 i_2 + 230 i_3 = 0$

$125 i_2 - 100 i_3 = 0$

$40 i_1 - 90 i_3 = -135$

$i_a = -2.25\,A \quad V_a = -90\,V$

$\frac{-V_b}{60} + \frac{-V_b}{30} + 16 = 0$

$3V_b = 1080$

$V_b = 360\,V$

$V_1 = 441.6 \quad V_2 = 192\ V$

$i_b = \frac{192}{40} = 4.8\ A$

$V = V_a + V_b = -90 + 360 = 270\ V$

$i_0 = -2.25 + 4.8 = 2.55\ A$

10) $-90 + 2000(i_1 - i_3) + 2.5 V_b = 0$

$V_b = 1000 i_3$

$2000 i_1 + 500 i_3 = 90$

$6000 i_2 - 6500 i_3 = 0$

$-2000 i_1 - 4000 i_2 + 7000 i_3 = 0$

$i_1 = 0.038\ A$

$i_2 = 0.0309\ A$

$i_3 = 0.028$

$i = i_1 - i_2 = 0.038 - 0.0308 = 7.2\ mA$

$2000 i_1 + 500 i_3 = 0$

$5000 i_2 - 6500 i_3 = -40$

$-2000 i_1 - 4000 i_2 + 7000 i_3 = 0$

$i_1 = 2.1\ mA \quad i_2 = -0.015\ A \quad i_3 = -8.42\ mA$

$i'' = i_1 - i_2 = 0.0179$

$2.7 \cdot 10^{-3} + 0.0179 = \boxed{25\ mA}$