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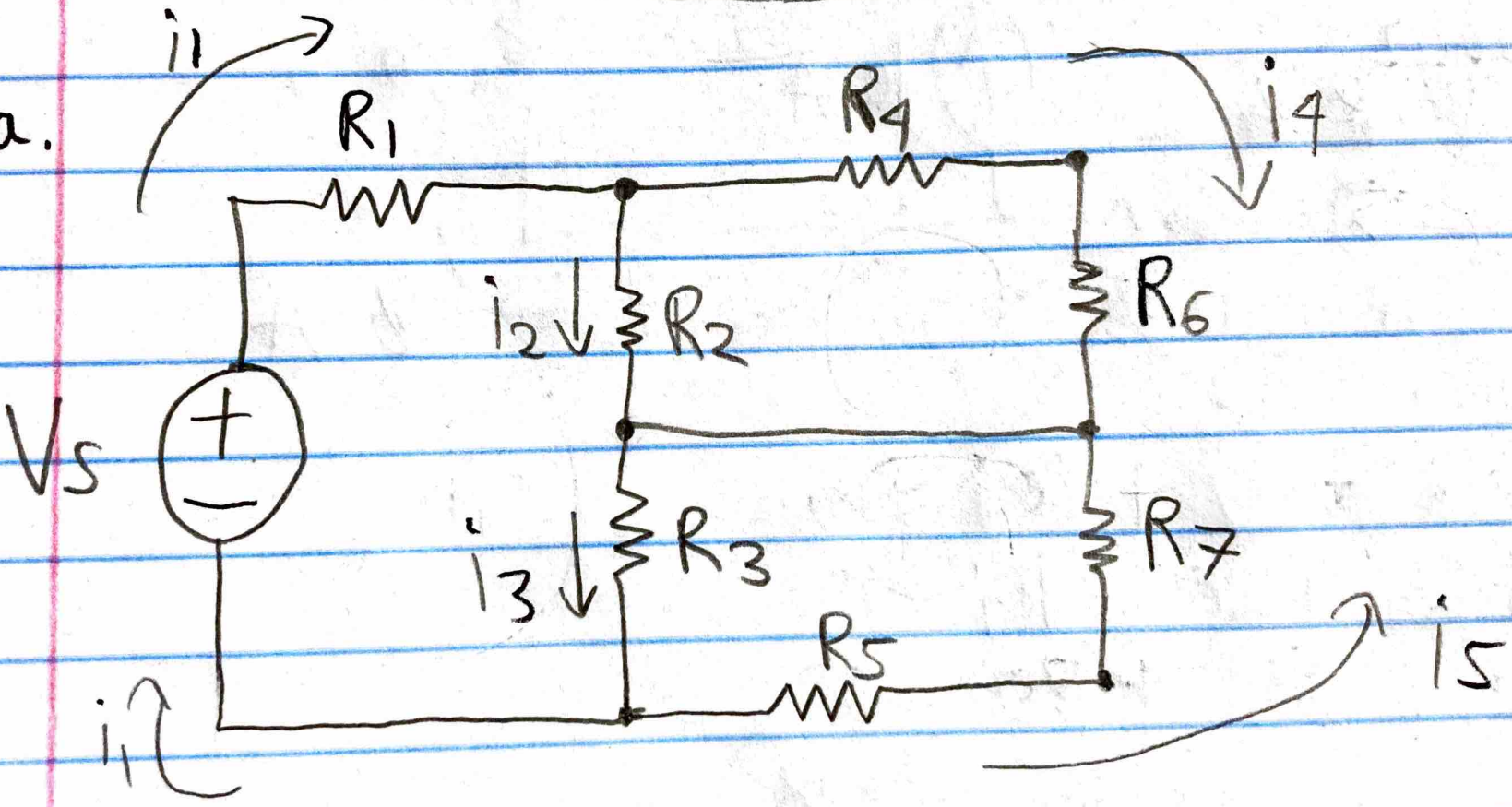
# Homework #4

4.3. a.




There are 5 unknown currents.

b. 4 essential nodes → 3 independent equations

c. $i_1 - i_2 - i_4 = 0$
$i_1 - i_2 - i_3 = 0$
$-i_1 + i_3 - i_5 = 0$
} Set of 3 KCL equations

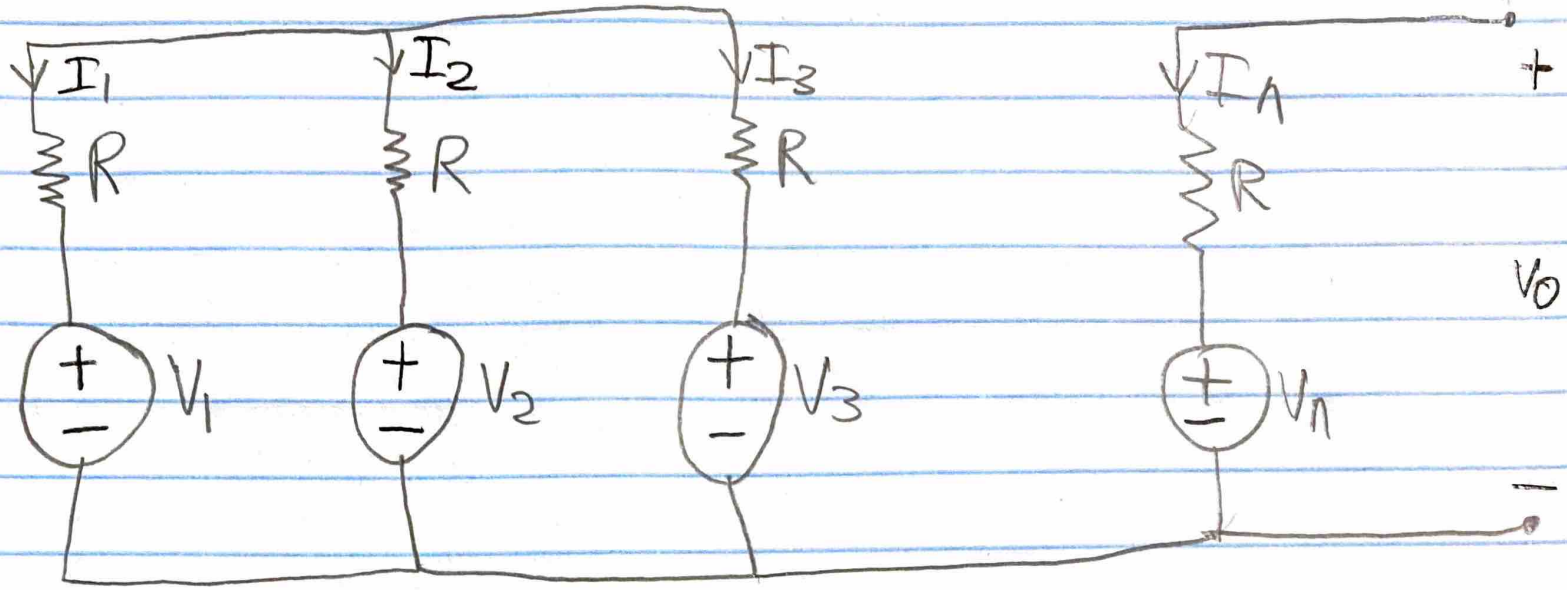
d. 5 variables need 5 equation to solve.

3 KCL Equations → set up

Also, 2 meshes → 2 KVL equations

e. $-V_S + i_1 R_1 + i_2 R_2 + i_3 R_3 = 0$
$-i_2 R_2 + i_4 (R_4 + R_6) = 0$
$i_3 R_3 + i_5 (R_5 + R_7) = 0$ //

4.10.




a. $$\frac{V_0 - V_1}{R} + \frac{V_0 - V_2}{R} + \frac{V_0 - V_3}{R} + \dots + \frac{V_0 - V_n}{R} = 0$$

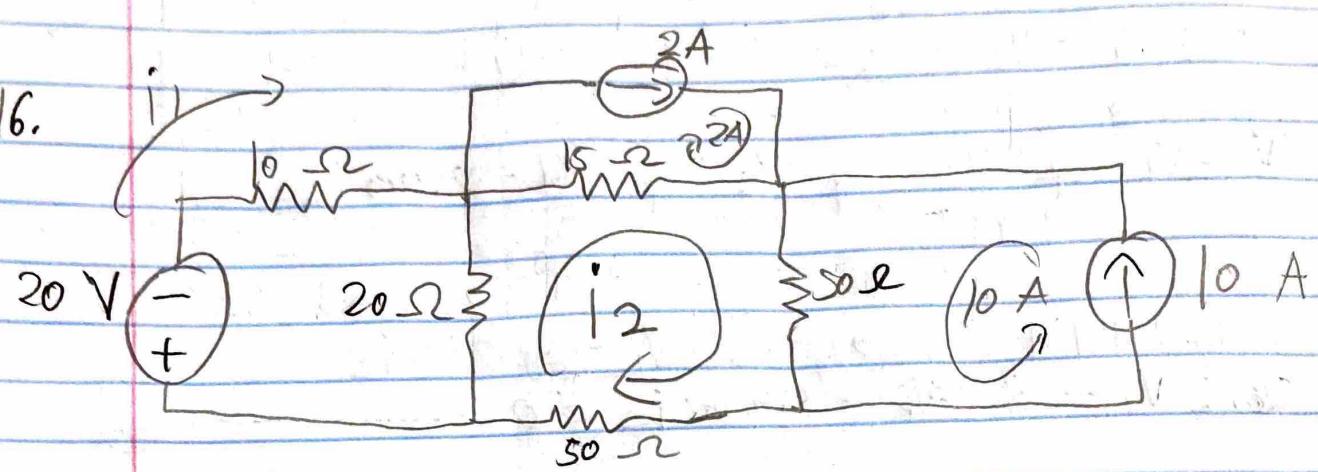
$$V_0\left(\frac{n}{R}\right) = \frac{V_1 + V_2 + V_3 + \dots + V_n}{R} \cdot \frac{R}{n}$$

$$V_0 = \frac{V_1 + V_2 + V_3 + \dots + V_n}{n}$$

(Demonstrated) //

4.10. b. $V_0 = \frac{100 + 80 - 60}{3} = \boxed{40\ V}$ //

4.16.




$$-20 + 10i_1 + 20(i_1 + i_2) = 0$$
$$-15(2) + 50(10 + i_2) + 50i_2 = 0$$

$$30i_1 + 20i_2 = 20$$
$$100i_2 = -470$$

$$1.5i_1 + i_2 = 1$$
$$-\quad i_2 = -4.7$$

$$1.5i_1 = 5.7 \rightarrow i_1 = 3.8$$

$$30i_1 + 20i_2 = 20$$
$$30(3.8) + 20i_2 = 20$$
$$20i_2 = -94$$
$$i_2 = -4.7 \text{ A}$$

| Power Sources | V | i | P (W) |
|---|---|---|---|
| 20 V | 20 | 3.8 | −76 |
| 10 A | 500 | 10 | −5000 |
| 2 A | 30 | 2 | −60 |

→ Total Power Dissipated = 5136 W

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

$V_1 (1 + 1.25) - V_2 = -25$

$2.25 V_1 - V_2 = -25$ ——— (1)

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

$V_2 (3.2 + 1 + 2 + 20) - 3.2 V_1 - 50000 i_\Delta = 0$

$26.2 V_2 - 3.2 V_1 - 50000 i_\Delta = 0$ ——— (2)

$i_\Delta = \frac{V_2 - V_1}{1250}$ ——— (3)

Substitute (3) in (2):

$26.2 V_2 - 3.2 V_1 - 50000 \left(\frac{V_2 - V_1}{1250}\right) = 0$

$26.2 V_2 - 3.2 V_1 - 40 V_2 + 40 V_1 = 0$

$-13.8 V_2 + 36.8 V_1 = 0$

$- V_2 + \frac{36.8}{13.8} V_1 = 0$ ——— (4)

Subt (4) w (1):

$2.25 V_1 - V_2 = 25$

$\frac{36.8}{13.8} V_1 - V_2 = 0$

$-0.42 V_1 = -25 \rightarrow V_1 = 60 \text{ V}$

$2.25(60) - V_2 = 25 \rightarrow V_2 = 160\ V$

$$i_\Delta = \frac{V_2 - V_1}{1250} = \frac{160 - 60}{1250} = 0.08\ A$$

$$P_{20mA} = V_1 \cdot 20 \cdot 10^{-3}$$
$$= 60 \cdot 20 \cdot 10^{-3}$$
$$= 1.2\ W$$

$$P_{2500 i_\Delta} = 2500 i_\Delta \cdot i$$
$$= 2500 i_\Delta \cdot \frac{V_2 - 2500 i_\Delta}{200}$$
$$= -40\ W$$

Conclusion:
Total power developed = (40 W)

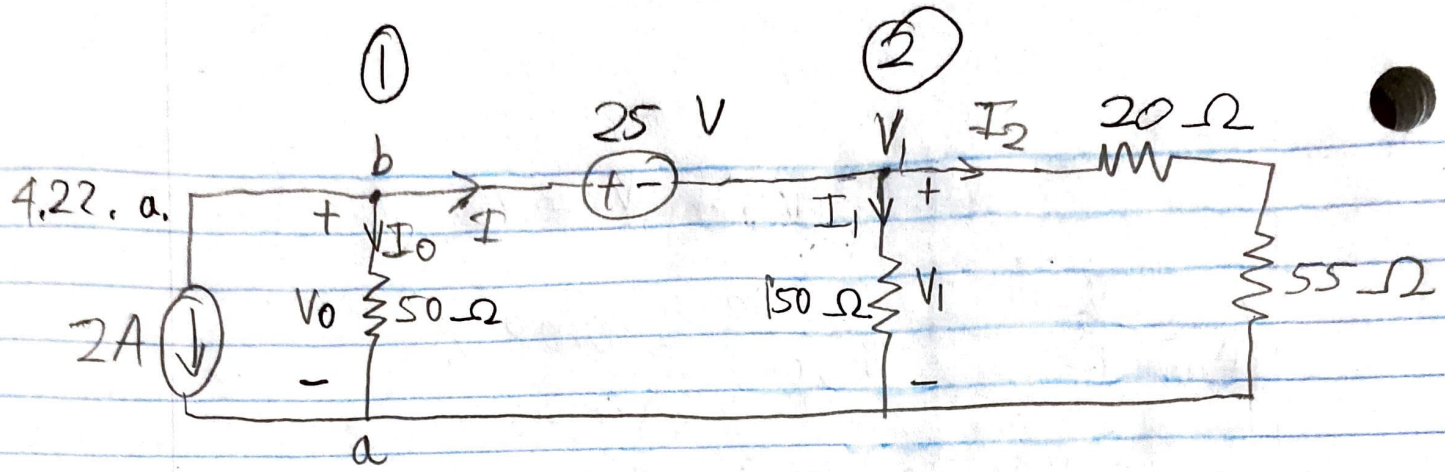
b. $$P_{dissipated} = \frac{(V_1)^2}{1000} + 1250(i_\Delta)^2 + \frac{(V_2)^2}{4000} + \frac{(V_2)^2}{2000} + i^2 \cdot 200$$

$$= \frac{60^2}{1000} + 1250(0.08)^2 + \frac{160^2}{4000} + \frac{160^2}{2000} + (-0.2)^2 \cdot 200$$

$$= 38.8\ W$$

$$P_{absorbed} = P_{dissipated} + P_{20mA}$$
$$= 38.8 + 1.2$$
$$= (40\ W) \rightarrow \text{Total power absorbed}$$

4.22. a.




Eq ①: $I_0 = \frac{V_0}{50}$ || $I_1 = \frac{V_1}{150}$ || $I_2 = \frac{V_1}{55+20} = \frac{V_1}{75}$

$$2 + \frac{V_0}{50} + \frac{V_1}{150} + \frac{V_1}{75} = 0$$

$$2 + \frac{V_0}{50} + \frac{V_1}{50} = 0$$

$$100 + V_0 + V_1 = 0$$

Eq ②: $V_1 = V_0 - 25$

$$\begin{aligned} V_0 + V_1 &= -100 \\ + \quad -V_0 + V_1 &= -25 \\ \hline 2V_1 &= -125 \\ V_1 &= -62.5 \text{ V} \end{aligned}$$

$$100 + V_0 - 62.5 = 0$$

$$V_0 + 37.5 = 0$$

$$V_0 = \boxed{-37.5 \text{ V}} //$$

$$P = -2V_0 = -2(-37.5) = \boxed{75 \text{ W}} //$$

b. $I_0 = \frac{V_a - V_b}{50} = \frac{-V_0}{50}$

$I_1 = \frac{V_a - V_1}{150} = \frac{-V_0 - (-25)}{150}$

$I_2 = \frac{V_a - V_1}{55+20} = \frac{-V_0 - (-25)}{75}$

$$-2 - \frac{V_0}{50} - \frac{V_0 - 25}{150} - \frac{V_0 - 25}{75} = 0$$

$$-300 - 3V_0 - V_0 + 25 - 2V_0 + 50 = 0$$

$$-6V_0 - 225 = 0$$

$$-6V_0 = 225 \rightarrow \boxed{V_0 = -37.5 \text{ V}}$$

$$P = -2V_0 = -2(-37.5) = \boxed{75 \text{ W}}$$