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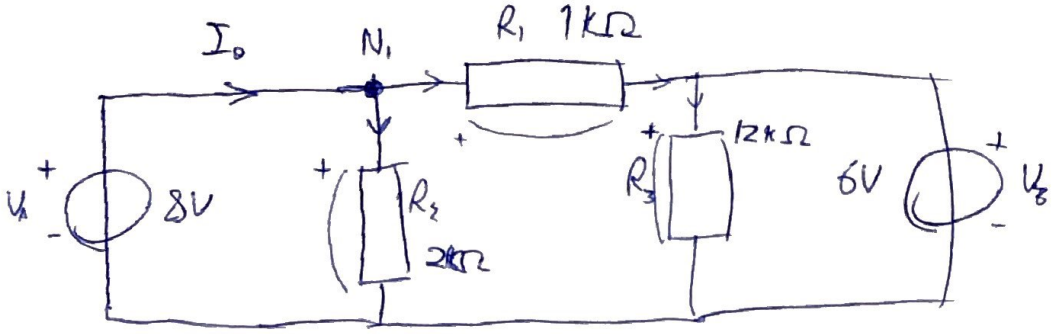
# Home Assignment 1

220513-5338

1.




KCL: $I_0 = \frac{V_{R2}}{R_2} + \frac{V_{R1}}{R_1}$ $\quad I_0 = \frac{V_{R2}}{2000} + \frac{V_{R1}}{1000}$

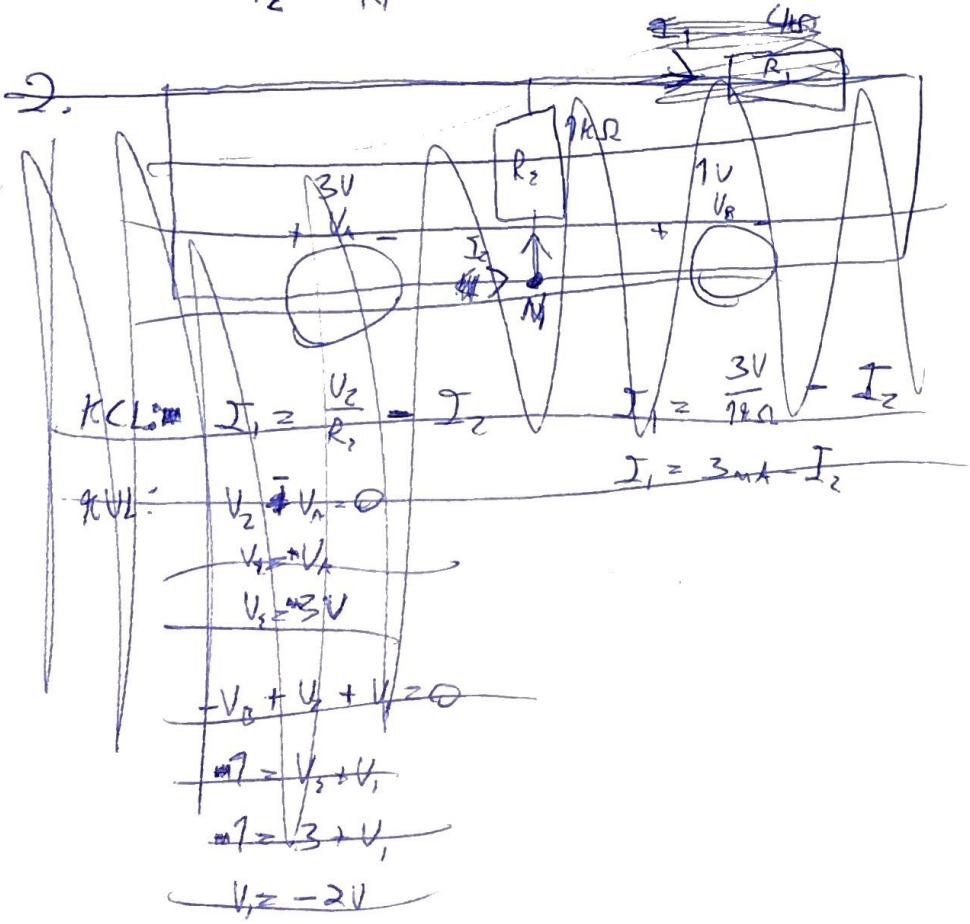
KVL: $-V_2 + V_A = 0$ $\quad -V_2 + 8 = 0$ $\quad V_2 = 8$

$V_2 - V_3 - V_1 = 0$ $\quad 8 = V_3 + V_1$ $\quad V_1 = 8 - V_3$ $\quad V_1 = 2$

$V_B - V_3 = 0$ $\quad V_3 = 6$

$$I_0 = \frac{V_2}{R_2} + \frac{V_1}{R_1} = \frac{8V}{2k\Omega} + \frac{2V}{1k\Omega} = 4mA + 2mA = \boxed{6mA}$$

2.




KCL: $I_1 = \frac{V_2}{R_1} - I_2$ $\quad I_1 = \frac{3V}{1k\Omega} - I_2$

$I_1 = 3mA - I_2$

KVL: $V_2 + V_A = 0$

$V_2 = -V_A$

$V_2 = -3V$

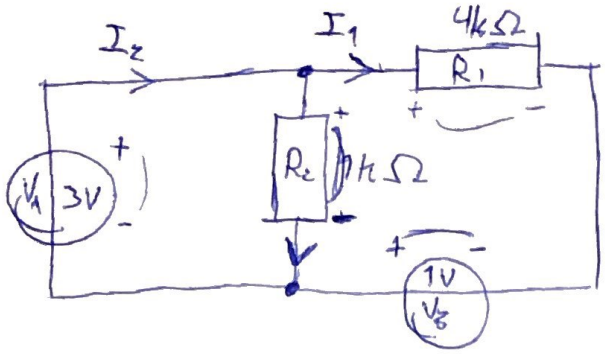
$-V_B + V_2 + V_1 = 0$

$-7 = V_2 + V_1$

$-7 = -3 + V_1$

$V_1 = -2V$

2.




$R_1 = 4k\Omega$

$R_2 = 1k\Omega$

$V_A = 3V$

$V_B = 1V$

$I_1 = ?$

$I_2 = ?$

KCL: $-I_1 = -I_2 + \frac{V_2}{R_2}$ $\qquad I_1 = \frac{V_1}{R_1} = \frac{V_1}{4k\Omega}$

$\Rightarrow -\frac{V_1}{4k\Omega} = -I_2 + \frac{V_2}{1k\Omega}$

$I_2 = \frac{V_2}{1k\Omega} + \frac{V_1}{4k\Omega}$

KVL: ~~$V_1 - V_2 = V_B$~~

$V_B + V_2 - V_1 = 0$ $\qquad V_2 - V_A = 0$

$V_1 = V_2 + 1$ $\qquad V_2 = V_A$

$V_2 = 3V$

$I_2 = \frac{V_2}{1k\Omega} + \frac{V_2 + 1}{4k\Omega}$

$I_2 = \frac{3V}{1k\Omega} + \frac{3+1}{4k\Omega}$

$= 3mA + 1mA$

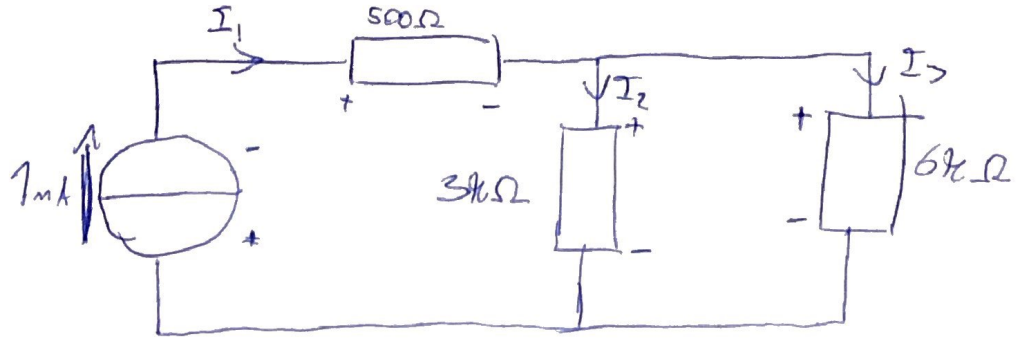
$= 4mA$

$I_1 = I_2 - \frac{V_2}{R_2}$

$I_1 = 4mA - 3mA$

$\boxed{I_1 = 1mA}$

3.




$I_1 = 1mA$ (circuit is in series / conservation of current)

KCL: $I_2 + I_3 = I_1$

$1mA = I_2 + I_3$

$V_2 = 3I_2\ V$

$V_3\ 6I_3\ V$

KVL: $V_2 - V_3 = 0$

$V_2 = V_3$

$3I_2 = 6I_3$

$I_2 = 2I_3$

$I_2 = 1mA - I_3$

$1 - I_3 = 2I_3$

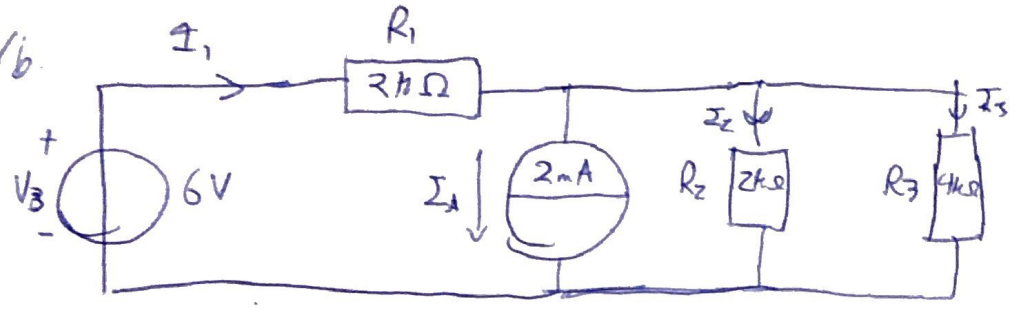
$1 = 3I_3$

$I_3 = \frac{1}{3}\ mA$

$I_2 = 2I_3 = \frac{2}{3}\ mA$

$I_1 = 1mA$

4a/b




$V_1 = I_1 R_1 = I_1 \cdot 2k\Omega = 2I_1\ V$

$V_2 = I_2 R_2 = I_2 \cdot 2k\Omega = 2I_2\ V$

$V_3 = I_3 R_3 = I_3 \cdot 4k\Omega = 4I_3\ V$

| | (V) $V$ | (mA) $I$ | (mW) $P$ |
|---|---|---|---|
| $R_1$ | 5.2 | 2.6 | 13.52 |
| $R_2$ | 0.8 | 0.4 | 0.32 |
| $R_3$ | 0.8 | 0.2 | 0.16 |
| $I_A$ | 0.8 | 2 | 1.6 |
| $V_B$ | -6 | 2.6 | -15.6 |

KCL: $I_1 = I_A + I_2 + I_3$

$I_1 = 2mA + I_2 + I_3$

KVL: $V_3 - V_2 = 0$

$4I_3 - 2I_2 = 0$

$4I_3 = 2I_2$

$I_2 = 2I_3$

$I_1 = 2mA + 2I_3 + I_3$

$I_1 = 2mA + 3I_3$

KVL: $V_B = V_1 + V_A = V_1 + V_3 = V_1 + V_2$

$V_A = V_2 = V_3 = -V_B - V_1$

$V_A = 2I_2 = 4I_3 = 6 - 2I_1$

$4I_3 = -6 - 2I_1$

$2I_1 = -6 - 4I_3$

$I_1 = -3 - 2I_3$

$3 - 2I_3 = 2 + 3I_3$

$1 = 5I_3$

$I_3 = \frac{1}{5}mA$

$I_2 = \frac{2}{5}mA \quad (2I_3 = \frac{2}{5}mA)$

$I_1 = \frac{13}{5}mA \quad (2 + \frac{3}{5} = 2 + 3I_3)$

$V_3 = \frac{4}{5}V \quad (4I_3)$

$V_2 = \frac{4}{5}V \quad (2I_2)$

$V_1 = \frac{26}{5}V \quad (2I_1)$

$I_A = 2mA$

$V_B = -6V$ (opposite to current flow)

$V_A = V_2 = \frac{4}{5}V$

$I_B = I_1$ (in series)

$I_B = \frac{13}{5}mA$

$P = I \cdot V$

$P_1 = 5.2 \cdot 2.6 = 13.52$

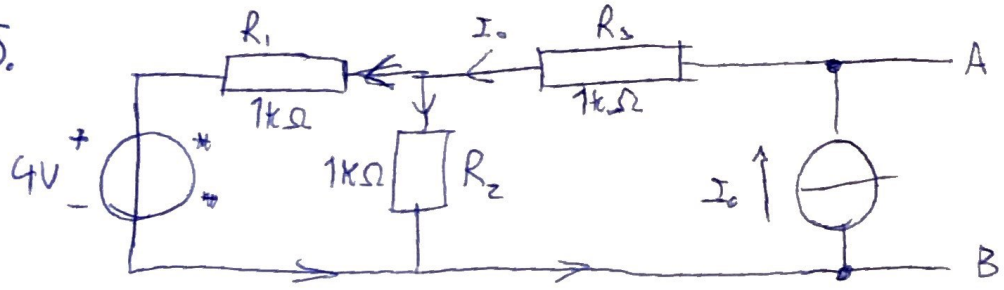
$P_2 = 0.8 \cdot 0.4 = 0.32$

$P_3 = 0.8 \cdot 0.2 = 0.16$

$P_A = 0.8 \cdot 2 = 1.6$

$P_B = -6 \cdot 2.6 = -15.6$

5.




a. $I_0 = 1mA$

KCL: $I_0 = \frac{V_1}{R_1} + \frac{V_2}{R_2} = \frac{V_1}{1k\Omega} + \frac{V_2}{1k\Omega} = \frac{V_1 + V_2}{1k\Omega}$ $\quad 1mA = \frac{V_1+V_2}{1k\Omega}$

$I_0 = \frac{V_3}{1k\Omega}$ $\quad 1mA = \frac{V_3}{1k\Omega}$ $\quad V_3 = 1V$ $\quad V_1 + V_2 = 1V$

$V_2 = 1 - V_1$

KVL: $4V + V_1 - V_2 = 0$

$V_2 = 4 + V_1$

$1 - V_1 = 4 + V_1$

$2V_1 = -3$

$V_1 = -1.5V$

$V_2 = 2.5V$

$V_3 = 1V$

KVL: $V_{AB} - V_2 - V_3 = 0$

$V_{AB} = V_2 + V_3 = 2.5 + 1V = 3.5V$

$P_4 = V_1 I_1 = -1.5V \cdot \frac{-1.5V}{1k\Omega} = 2.25mW$

$P_0 = V_{AB} I_0 = 3.5V \cdot 1mA = 3.5mW$

b. $I_0 = 10mA = \frac{V_1 + V_2}{1k\Omega}$ $\quad V_1 + V_2 = 10V$

$V_2 = 10 - V_1$

$10mA = \frac{V_3}{1k\Omega}$ $\quad V_3 = 10V$

$V_2 = 4 + V_1$

$10 - V_1 = 4 + V_1$

$2V_1 = 6$

$V_1 = 3V$

$V_2 = 10 - 3 = 7V$

$V_3 = 10V$

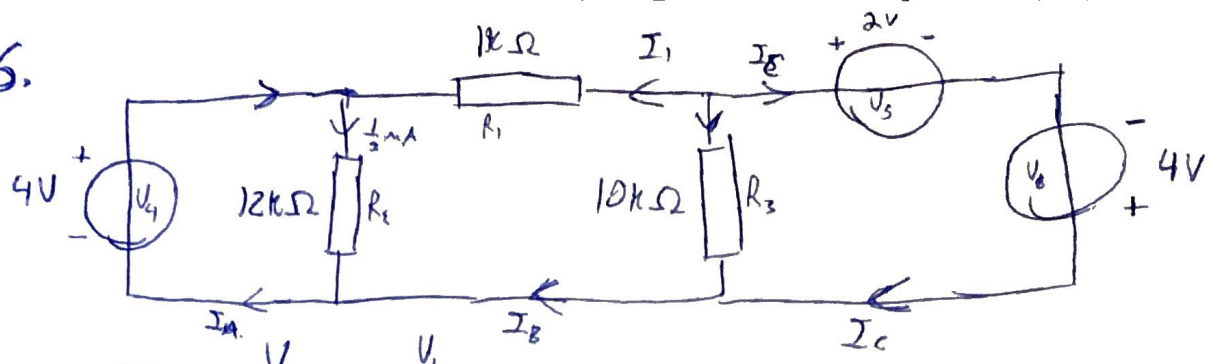
$V_{AB} - V_2 - V_3 = 0$

$V_{AB} = V_2 + V_3 = 10V + 7V = 17V$

$P_4 = V_1 I_1 = 3V \cdot \frac{3V}{1k\Omega} = 9mW$

$P_0 = V_{AB} I_0 = 17V \cdot 10mA = 170mW$

6.




$$I_1 = \frac{V_1}{R_1} = \frac{V_1}{1k\Omega}$$

$$-I_1 = I_E + \frac{V_3}{R_3} = I_E + \frac{V_3}{10k\Omega}$$

$$V_5 - V_6 - V_3 = 0$$

$$2 - 4 = V_3$$

$$V_3 = -2V$$

$$-I_1 = I_E - \frac{2}{10k\Omega} = I_E - 0.2\,mA$$

$$I_1 = 0.2mA - I_E$$

KVL: $4V - V_2 = 0$

$$V_2 = 4V$$

$$I_2 = \frac{V_2}{R_2} = \frac{4V}{12k\Omega} = \frac{1}{3}\,mA$$

~~KCL: $I_A = \frac{1}{3}mA - I_1$~~

~~$I_B = \frac{1}{3}mA + I_A$~~

~~$I_B = \frac{1}{3}mA + \frac{1}{3}mA - I_1$~~

~~$I_E = I_1$~~

KVL: $V_2 - V_3 + V_1 = 0$

$$V_1 = V_3 - V_2$$

$$V_1 = -2 - 4 = -6V$$

$$\boxed{I_1 = \frac{V_1}{R_1} = \frac{-6V}{1k\Omega} = -6mA}$$