2.1

(1) $\frac{V_a}{6\times10^3}+\frac{V_b}{30\times10^3}=\frac{-V_o}{300\times10^3}$ $\therefore V_o=-5V$

(2) 当运放饱和时，$V_o=-10V$

~~$\therefore \frac{V_a}{6\times10^3}+\frac{V_b}{30\times10^3}=\frac{0-V_o}{300\times10^3}$，$V_b=$~~

$\therefore \frac{V_a}{6\times10^3}+\frac{V_b}{30\times10^3}=\frac{0-V_o}{300\times10^3}$ $\therefore V_b=0.75V$

(3) 由 $\frac{V_a}{6\times10^3}+\frac{V_b}{30\times10^3}=\frac{-V_o}{300\times10^3}$，$V_o=-10V$，$V_b=0.25V$

$\therefore V_a=0.15V$

2.2

(1) $\frac{0-V_a}{5\times10^3}=\frac{V_a-V_o}{40\times10^3}$

$V_a=V_b$

$\frac{600\times10^{-3}-V_b}{20\times10^3}=\frac{V_b-0}{60\times10^3}$

$$\therefore \begin{cases} V_o=4.05V \\ V_a=0.45V \\ V_b=0.45V \end{cases}$$

(2) 当运放饱和时，$V_o=-5V$

$\frac{0-V_a}{5\times10^3}=\frac{V_a-V_o}{40\times10^3}$

$V_a=V_b$

$\frac{600\times10^{-3}-V_b}{20\times10^3}=\frac{V_b}{R_x}$

$\therefore R_x=2.5\times10^5\Omega$

2.4

(4) ① $V_n = 0$

$$\frac{V_g - V_n}{5\times10^3} = \frac{V_n - V_o}{50\times10^3} \quad \therefore \frac{V_o}{V_g} = -10$$

~~$\frac{V_g - V_n}{5\times10^3} = \frac{V_n - V_o}{50\times10^3}$ $\therefore \frac{V_o}{V_g} = -10$~~

~~$\therefore V_o =$~~

② ∵运放理想 $\therefore V_n = 0$

③ $R_g = 5\times10^3 + 50\times10^3 = 55\times10^3\,\Omega$

2.5

$$\frac{V_i - V_n}{R_1} = \frac{V_n - V_1}{R_2}$$

$$\frac{V_n - V_1}{R_2} + \frac{0 - V_1}{R_4} = \frac{V_1 - V_o}{R_3}$$

$V_n = 0$

$$\therefore \frac{V_i}{R_1} + \frac{R_2 V_i}{R_1 R_4} = \frac{-\frac{R_2}{R_1}V_i - V_o}{R_3}$$

$$\therefore \frac{1}{R_1} + \frac{R_2}{R_1 R_4} = \frac{-\frac{R_2}{R_1} - A_f}{R_3}$$

$$\therefore A_f = -\left(\frac{R_3}{R_1} + \frac{R_2 R_3}{R_1 R_4} + \frac{R_2}{R_1}\right) = -\frac{R_2}{R_1}\left(1 + \frac{R_3}{R_4} + \frac{R_3}{R_2}\right)$$

2.6 $100 = 5^2 \times 2^2$

$A_f = -\frac{R_2}{R_1}\left(1+\frac{R_3}{R_4}+\frac{R_3}{R_2}\right) = -\frac{R_2}{R_1}\left(2+\frac{R_3}{R_4}\right)$

∴ 当 $\frac{R_2}{R_1}=2$，$2+\frac{R_3}{R_4}=50$ 时，满足条件，且电阻为整数值

此时，$R_1=51k\Omega$，$R_2=R_3=102k\Omega$，$R_4=2.04k\Omega$.

2.10

$$\frac{V_{11}-V_1}{R_1}+\frac{V_{12}-V_1}{R_2}=\frac{V_1-V_0}{R_f}$$

$$\frac{V_{13}-V_2}{R_A}+\frac{V_{14}-V_2}{R_B}=\frac{V_2}{R_C}$$

$$V_1=V_2$$

$$\therefore \frac{V_{11}}{R_1}+\frac{V_{12}}{R_2}+\frac{V_0}{R_f}=\left(\frac{1}{R_1}+\frac{1}{R_2}\right)V_1+\frac{V_2}{R_f}=\frac{V_1}{R_n}+\frac{V_1}{R_f}$$

$$\frac{V_{13}}{R_A}+\frac{V_{14}}{R_B}=\left(\frac{1}{R_A}+\frac{1}{R_B}+\frac{1}{R_C}\right)V_1=\frac{V_1}{R_p}$$

$$\therefore \frac{V_{11}}{R_1}+\frac{V_{12}}{R_2}+\frac{V_0}{R_f}=\frac{R_p}{R_n}\left(\frac{V_{13}}{R_A}+\frac{V_{14}}{R_B}\right)+\frac{R_p}{R_f}\left(\frac{V_{13}}{R_A}+\frac{V_{14}}{R_B}\right)$$

$$\therefore V_0=-\frac{R_f}{R_1}V_{11}-\frac{R_f}{R_2}V_{12}+R_f\left[\frac{R_p}{R_A}\left(\frac{V_{13}}{R_n}+\frac{V_{13}}{R_f}\right)+\frac{R_p}{R_B}\left(\frac{V_{14}}{R_n}+\frac{V_{14}}{R_f}\right)\right]$$

$$=-\frac{R_f}{R_1}V_{11}-\frac{R_f}{R_2}V_{12}+\left(1+\frac{R_f}{R_n}\right)\left[\frac{R_p}{R_A}V_{13}+\frac{R_p}{R_B}V_{14}\right]$$

2.11 R单位均为kΩ.

由2.10知：

$\frac{R_f}{R_1}=10$，$\frac{R_f}{R_2}=4$，$(1+\frac{R_f}{R_n})\frac{R_P}{R_A}=5$，$(1+\frac{R_f}{R_n})\frac{R_P}{R_B}=2$.

$R_1=20$，$R_f=200$，则 $R_2=50$　∴ $R_n=\frac{100}{7}$

∴ $(1+\frac{R_f}{R_n})=15$　∴ $\frac{R_P}{R_A}=\frac{1}{3}$，$\frac{R_P}{R_B}=0\frac{2}{15}$

$=\frac{20}{60}$　$=\frac{20}{150}$

∴令 $R_P=20$，$R_A=60$，$R_B=150$，则 $R_L=37.5$