6.2

u_I/V	0.1	0.5	1.0	1.5
u_{O1}/V	-1 V	-5 V	-10 V	-14 V
u_{O2}/V	1.1 V	5.5 V	11 V	14 V

$u_{O1} = -\frac{R_f}{R} u_I = -10 u_I$

$u_{O2} = (1 + \frac{R_f}{R}) u_I = 11 u_I$

6.4 $I_{in} = \frac{u_I - u_N}{R_1} = \frac{u_I}{R_1}$ $\therefore \frac{u_I}{I_{in}} = R_1$ $\therefore R_{in} = R_1$

输入电阻为10 kΩ

$I_{in} = I_{R2} = \frac{u_I}{R_1}$ $\frac{0 - u_M}{R_2} = \frac{u_I}{R_1}$ $\therefore u_M = -\frac{R_2}{R_1} u_I$

$I_{R4} = \frac{-u_M}{R_4} = \frac{R_2}{R_1 R_4} u_I$

$\therefore -u_O = I_{R2} R_2 + I_{R3} \cdot R_3 = I_{R2} \cdot R_2 + (I_{R2} + I_{R4}) R_3$

$= I_{R2} (R_2 + R_3) + I_{R4} \cdot R_3$

$= \frac{u_I}{R_1} (R_2 + R_3) + \frac{u_I R_2}{R_1 R_4} R_3$

$= 4 u_I + u_I \times 100$

$= 104 u_I$

$\therefore u_O = -104 u_I$ ∴比例系数为-104

6.5 (1) R_2短路 即 $R_2 = 0$ $\therefore -u_O = \frac{u_I}{R_1} R_3 = 2 u_I$

$\therefore u_O = -2 u_I = -4 V$

(2) R_3短路 $R_3 = 0$ $-u_O = \frac{u_I}{R_1} R_2 = 2 u_I$ $\therefore u_O = -2 u_I$

$u_O = -4 V$

(3) R_4 短路

负反馈断开 $u_o = -14\ V$.

(4) R_1 断路 $R_1 \to \infty$ $\quad -u_o = \frac{u_{I1}}{R_1}(R_2+R_3) = 4u_{I1}$

$\therefore u_o = -8\ V$

6.6 (a) $u_o = -\frac{R_f}{R_1}u_{I1} - \frac{R_f}{R_2}u_{I2} + \left(1+\frac{R_f}{R_1 /\!/ R_2}\right)u_{I3}$

$= -2u_{I1} - 2u_{I2} + (1+4)u_{I3}$

$= -2u_{I1} - 2u_{I2} + 5u_{I3}$

(b) ~~$u_o - \frac{R_f}{R_1}u_N = -\frac{R_f}{R_1}u_p$~~ $u_N - u_o = \frac{u_{I1}-u_N}{R_1}\cdot R_f$

$u_p = \frac{R_2}{R_2+R_3}u_{I3} + \frac{R_3}{R_2+R_3}u_{I2}$ $\quad \therefore u_o = u_N - \frac{u_{I1}-u_N}{R_1}R_f$

$= u_N - 10(u_{I1}-u_N)$

~~$\therefore u_o = -\frac{R_f}{R_1}\left(\frac{R_3}{R_2+R_3}u_{I2} + \frac{R_2}{R_2+R_3}u_{I3}\right)$~~ $= 11u_N - 10u_{I1}$

$= 11u_p - 10u_{I1}$

~~$= -10\left(\frac{10}{11}u_{I2} + \frac{1}{11}u_{I3}\right)$~~ $\therefore u_o =$

$11\left(\frac{10}{11}u_{I2} + \frac{1}{11}u_{I3}\right) - 10u_{I1}$

$= 10u_{I2} + u_{I3} - 10u_{I1}$

(c) $\frac{u_{I1}-u_N}{R_1}R_f = u_N - u_o$

$u_N = u_p$ $\quad \therefore u_o = u_N - \frac{u_{I1}-u_N}{R_1}R_f$

$u_p = \frac{u_{I2}\cdot R_f}{R_1+R_f}$ $\quad = u_N - \frac{u_{I1}-u_N}{2k}\cdot 2k$

$\frac{2k\Omega}{1k} = k_u - R$ $\quad = u_N - 8u_{I1} + 8u_N = 9u_N - 8u_{I1}$

$u_p = \frac{u_{I2}\times 2k}{2k} = \frac{8u_{I2}}{9}$ $\quad = 8u_{I2} - 8u_{I1}$

$k_u = \frac{2k}{1k}$ $\quad \therefore u_o = 8u_{I2} - 8u_{I1}$

(d) u_{I1} 单独作用 $u_{o1} = -\frac{R_f}{R_1} u_{I1} = -20 u_{I1}$

u_{I2} 单独作用 $u_{o2} = -20 u_{I2}$

u_{I3} 单独作用 $u_{o3} = \left(1 + \frac{R_f}{R_1 // R_2}\right) \times \frac{R_4}{R_4 + R_3} \times u_{I3}$

$= \left(1 + 40\right) \times \frac{200}{205} \times u_{I3}$

$= (1 + 40) \times \frac{40}{41} \times u_{I3} = 40 u_{I3}$

u_{I4} 单独作用 $u_{o4} = \left(1 + \frac{R_f}{R_1 // R_2}\right) \frac{R_3}{R_3 + R_4} u_{I4}$

$= (1 + 40) \times \frac{5}{205} \times u_{I4} = u_{I4}$

$\therefore u_o = -20 u_{I1} - 20 u_{I2} + 40 u_{I3} + u_{I4}$

6.9 (1) $u_N = u_P = \frac{u_{I2} \cdot R_f}{R + R_f} = \frac{10}{11} u_{I2}$

$\frac{u_{I1} - u_N}{R} = \frac{u_N - \frac{u_o R_1}{R_w}}{R_f}$

$\therefore \frac{u_{I1} - u_N}{R} \cdot R_f = u_N - \frac{u_o R_1}{R_w} = (u_{I1} - u_N) / 0$

$\therefore 11 u_N = 10 u_{I1} + \frac{u_o R_1}{R_w} = 10 u_{I2}$

$\therefore u_o = \left(10 u_{I2} - 10 u_{I1}\right) \frac{R_w}{R_1}$

(2) $u_o = 10 (u_{I2} - u_{I1}) = 100\ mV$

(3) 当 $u_{I2} = 20\ mV$ $u_{I1} = 0$ 时 $u_o = 10 \times 20\ mV \times \frac{R_w}{R_w + R_2}$

$= 14\ V$

$R_2 = 9.86\ k\Omega$

$\therefore R_2$ 最大为 $9.86\ k\Omega$

6.10 (a) u_{I1} 单独作用 $u_N = u_P = 0$

$$\frac{u_{I1}}{R_1} \cdot R_3 = -u_M \qquad u_{R4} = \left(\frac{u_{I1}}{R_1} \cdot R_3 + \frac{-u_M}{R_5}\right) R_4$$

$$\therefore -u_o = \frac{u_{I1}}{R_1} R_3 + \left(\frac{u_{I1}}{R_1} - \frac{u_M}{R_5}\right) R_4$$

$$u_o = -\frac{R_3}{R_1} u_{I1} + \left(\frac{u_M}{R_5} - \frac{u_{I1}}{R_1}\right) R_4$$

$$= \left(-\frac{R_3}{R_1} - \frac{R_4}{R_1}\right) u_{I1} + \frac{u_M \cdot R_4}{R_5}$$

$$= \frac{u_M \cdot R_4}{R_5} - \left(\frac{R_4 + R_3}{R_1}\right) u_{I1}$$

$$= -\frac{R_3}{R_1} \cdot \frac{R_4}{R_5} \cdot u_{I1} - \frac{R_3 + R_4}{R_1} u_{I1}$$

$$= -\left(\frac{R_3 R_4}{R_1 R_5} + \frac{R_3 + R_4}{R_1}\right) u_{I1}$$

$$\therefore u_o = -\left(\frac{R_3 R_4}{R_1 R_5} + \frac{R_3 + R_4}{R_1}\right) u_{I1}$$

(b)

$$\frac{u_I}{R_1} \cdot R_3 = u_{o1} - u_I \qquad u_{o1} = u_I + \frac{R_3}{R_1} u_I = \left(1 + \frac{R_3}{R_1}\right) u_I$$

$$\frac{u_{o1}}{R_4} \cdot R_5 = -u_o \qquad u_o = -\frac{R_5}{R_4}\left(1 + \frac{R_3}{R_1}\right) u_I \quad \because R_3 R_5 = R_1 R_4$$

$$= -\left(\frac{R_5}{R_4} + 1\right) u_I$$

$$\therefore u_o = -\left(1 + \frac{R_5}{R_4}\right) u_I$$

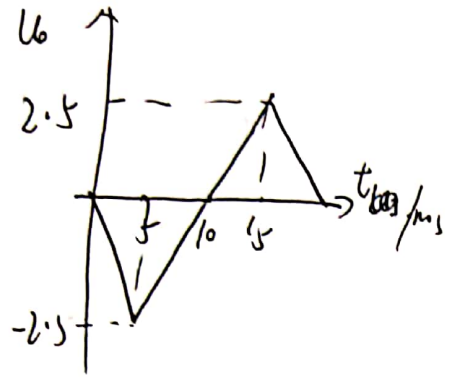
(c) $\because R_P = R_1 // R_1 // R_2$ $\therefore u_P = \frac{(u_{I3} + u_{I1} + u_{I2})}{R_1 + R_P} R_P = \frac{(u_{I1} + u_{I2} + u_{I3})}{R_1 + R_P} R_P$

$u_N = u_P = \frac{u_o R_3}{R_4 + R_3}$ $\therefore u_o = \frac{R_4 + R_3}{R_3} \cdot \frac{R_P}{R_1 + R_P} \times (u_{I1} + u_{I2} + u_{I3})$

6.1 (1) $\frac{u_I}{R} = i_C$ $\quad -u_o = \frac{1}{C}\int_0^t \frac{u_I}{R}\,dt$

$u_o = -\frac{1}{RC}\int_0^t u_I\,dt$.

(2) $= -100\int_0^t u_I\,dt$.



6.14 (1) $u_N = u_P = \frac{u_o}{2}$ $\quad \frac{u_I - \frac{u_o}{2}}{R_1} = \frac{\frac{u_o}{2} - u_{o1}}{R_f}$.

$\therefore u_I + u_{o1} = u_o$ $\quad i_C = \frac{u_{o1} - u_o}{R} = -\frac{u_I}{R}$.

$\therefore u_o = \frac{1}{C}\int_0^t -\frac{u_I}{R}\,dt = -\frac{1}{RC}\int_0^t u_I\,dt$.

$= -10\int_0^t u_I\,dt$

(2) $u_I = -1$ $\quad u_o = 10t = 6$ $\quad \therefore t = 0.6\,s$

$\therefore$ 需要 0.6 s

6.16 (1) $V_B = u_{I1} = 4\,V$ $\quad V_C = u_{I2} = 1\,V$.

$\therefore V_A = 7\,V$ $\quad V_D = -2\,V$. $\quad u_{N4} = -2\,V$.

$u_{O3} = 0$ $\quad \therefore i = \frac{2}{R}$ $\quad \therefore iR = 2V$.

$\therefore u_o = -4\,V$

(2) $t = 0$ $\quad u(c) = 0\,V$

打开后 $u_{C1} = \frac{1}{C}\int_0^t \frac{u_A}{R_1}dt = u_{O1} - U_{O3}$

$\therefore U_{O3} = -\frac{1}{R_1 C}\int_0^t u_A dt$

$= -20\int_0^t 7\,dt = -140t$

$\frac{U_{O3}+2}{R}\cdot R = -2 - u_O = U_{O3} + 2 = -140t + 2$

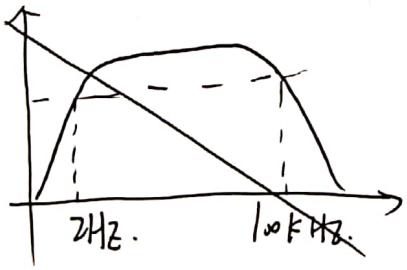
$\therefore u_O = 140t - 4$

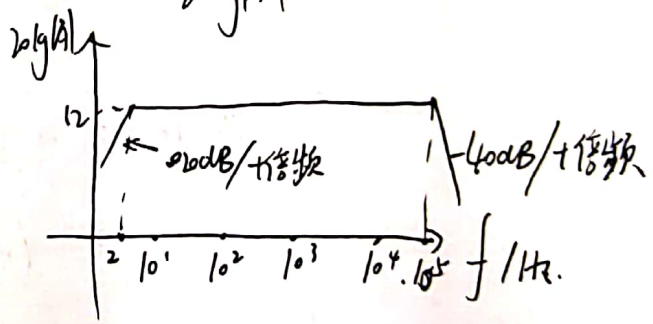
$t = \frac{1}{35}$ s 时 $u_O = 0$.

6.21

$\dot{A}_u = 4$

$20\lg|\dot{A}_u| \approx 12$





6.22 $\dot{A}_{up} = 1 + \frac{R_2}{R_1} = 2 \quad \therefore R_1 = R_2$

$f_0 = f_p = \frac{1}{2\pi RC}$ 得 $R \approx 160\,k\Omega$

同相输入端与反相输入端电阻相等

$R_1 // R_2 = 2R \quad \therefore R_1 = R_2 = 4R \approx 640\,k\Omega$.