1.

a: $H(w) = \dfrac{10j\,(1+jw/500)}{(1+jw/50)(1+jw/2124)}$. 4'

b: $H(w) = \dfrac{10j\,(1+jw/2)}{(1+jw/20)(1+jw/100)}$. 4'

2. (a). $z_{in} = \dfrac{1}{1+\frac{1}{jwL}+\frac{1}{\frac{1}{jwC}+0.1}}$.

$= \dfrac{1}{1+\frac{1}{jwL}+\frac{1}{0.1-\frac{j}{wC}}}$. $= \dfrac{1}{1+\frac{1}{jwL}+\frac{0.1+\frac{j}{wC}}{(0.1)^2+(\frac{1}{wC})^2}}$.

$= 1+\dfrac{0.1}{(0.1)^2+(\frac{1}{wC})^2}+j\left[\dfrac{1}{[(0.1)^2+(\frac{1}{wC})^2]wC}-\dfrac{1}{wL}\right]$. 4'

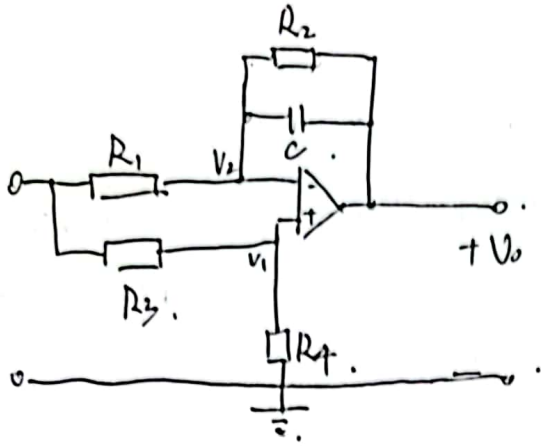
w_0: $w_{0L} = w_0C\left[(0.1)^2+(\dfrac{1}{w_0C})^2\right]$

$(\dfrac{1}{w_0L})^2 = \dfrac{L}{C}-0.01$. $\Rightarrow w_0 = 235].03$ rad/s. 4'

(b). $z_{in} = 1+\dfrac{0.1}{(0.1)^2+(\frac{1}{w_0C})^2}$.

$= 1+\dfrac{0.1}{\frac{L}{C}} = 1.00\,\Omega$. 4'.

3.



$$V_2 = V_1 = V_s \cdot \frac{R_4}{R_3+R_4}.$$

$$V_o = V_2 - (V_s - V_2) \times \frac{R_2 \parallel \frac{1}{jwC}}{R_1}$$

$$= V_2 - V_s \frac{R_3}{R_3+R_4} \times \frac{\frac{R_1 \frac{R_2}{jwC}}{\frac{1}{jwC}+R_2}}{R_1}.$$

$$= V_s \cdot \frac{R_4}{R_3+R_4} - V_s \frac{R_3}{R_3+R_4} \times \frac{R_2}{R_1(1+jwCR_2)}$$

$$= V_s \cdot \frac{R_4}{R_3+R_4} \times \frac{jw + \frac{1}{R_1C}\left(\frac{R_1}{R_2} - \frac{R_3}{R_4}\right)}{jw + \frac{1}{R_2C}}.$$

$$H(w) = \frac{R_4}{R_3+R_4} \times \frac{jw + \frac{1}{R_1C}\left(\frac{R_1}{R_2} - \frac{R_3}{R_4}\right)}{jw + \frac{1}{R_2C}}. \quad 4'$$

① case 1: $R_4 \neq 0$. and. $\frac{R_1}{R_2} = \frac{R_3}{R_4}$. 2'

$$H(w) = \frac{R_4}{R_3+R_4} \times \frac{jw}{jw + \frac{1}{R_2C}} \Rightarrow \text{High-pass filter.} \quad 2'$$

② Case2: $R_4 = 0$. 2'

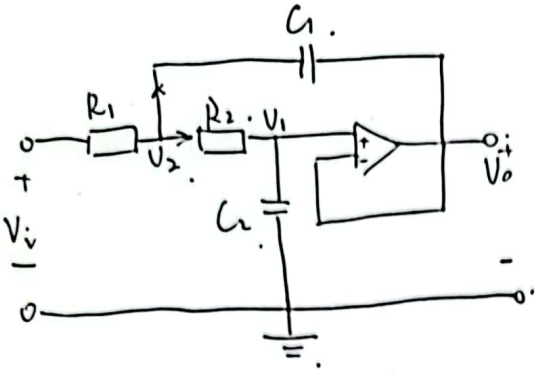
$$H(w) = \frac{-\frac{1}{R_1C}}{jw + \frac{1}{R_2C}} \Rightarrow \text{Low-pass filter.} \quad 2'$$

other cases. not imply a classical. filter.

多写 删掉如方.

4.

a:



$V_1 = V_o$.

$$\frac{V_2 - V_1}{R_2} = \frac{V_1}{\frac{1}{jwC_2}}$$

$$\frac{V_2 - V_1}{R_2} = jwC_2V_1$$

$$V_2 = (jwC_2R_2 + 1)V_1$$

$$= (jwC_2R_2 + 1)V_o$$

$$\frac{V_i - V_2}{R_1} = \frac{V_2 - V_o}{\frac{1}{jwC_1}} + \frac{V_2 - V_o}{R_2}$$

$$\frac{V_i - V_2}{R_1} = jwC_2R_2V_o\left(jwC_1 + \frac{1}{R_2}\right)$$

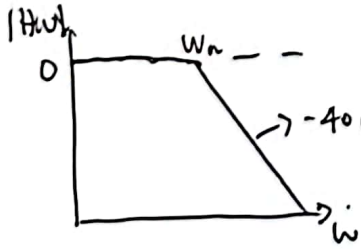
$$= V_o \cdot jwC_2(jwC_1R_2 + 1)$$

$$V_i = V_o \cdot jwC_2R_1(jwC_1R_2 + 1) + V_o(1 + jwC_2R_2)$$

$$= V_o(1 + jw(C_2(R_1 + R_2)) + C_1C_2R_1R_2(jw)^2)$$

$$H(w) = \frac{V_o}{V_i} = \frac{1}{1 + 2(jw)/\frac{2}{C_2(R_1+R_2)} + \left(\frac{jw}{\frac{1}{\sqrt{C_1C_2R_1R_2}}}\right)^2}$$ 4'

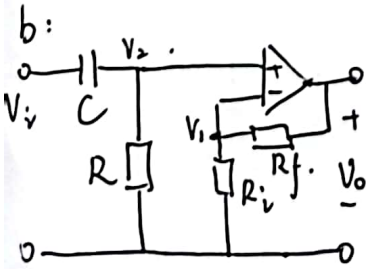
Bode plot:



$$w_n = \frac{1}{\sqrt{C_1C_2R_1R_2}}$$

low-pass filter. 2'.

b:



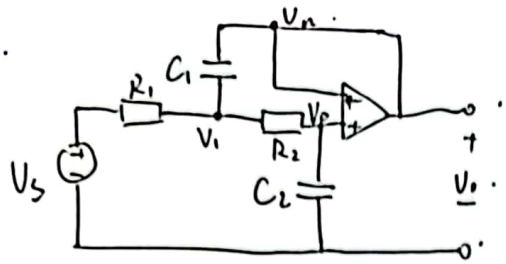
$$V_1 = V_2 \cdot \frac{R_i}{R_i + R_f} = V_2$$

$$V_i \cdot \frac{R}{R + \frac{1}{jwC}} = V_2 = V_o \cdot \frac{R_f}{R_i + R_f}$$

$$\frac{V_o}{V_i} = \frac{\frac{jwCR}{jwCR + 1}}{\frac{R_f}{R_i + R_f}} = \left(1 + \frac{R_f}{R_i}\right) \cdot \frac{jwRC}{1 + jwRC}$$ 4'

high-pass filter. 2'.

5.



(a) For V_1:

① $\frac{V_1 - V_o}{1/jwC_1} + \frac{V_1 - V_s}{R_1} + \frac{V_1}{R_2 + 1/jwC_2} = 0.$

② $V_p = V_n = V_o.$

③ $V_p = \frac{V_1 / jwC_2}{R_2 + 1/jwC_2}.$ 2'.

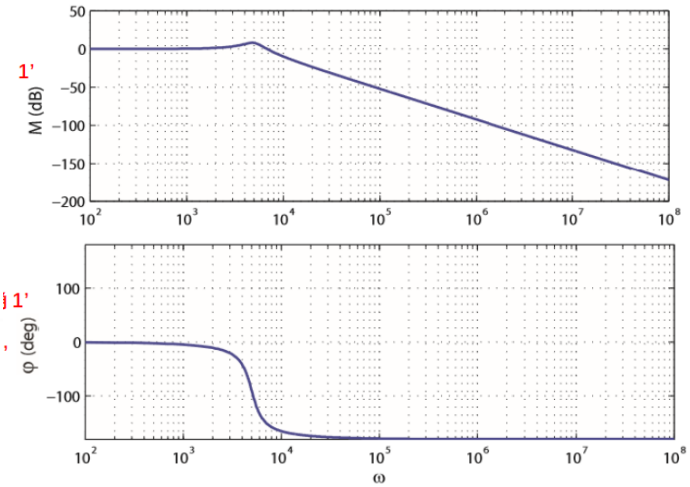
$$\Rightarrow H(w) = \frac{V_o}{V_s} = \frac{1}{1 + jw(R_1+R_2)C_2 + (jw\sqrt{R_1R_2C_1C_2})^2}.$$

$$= \frac{1}{1 + j2\xi w/w_c + (jw/w_c)^2}.$$ 2'

with: $w_c = \frac{1}{\sqrt{R_1R_2C_1C_2}} = \frac{1}{\sqrt{100\times100\times10^{-5}\times0.4\times10^{-6}}} = 5000$ rad/s.

$$\xi = \frac{(R_1+R_2)C_2w_c}{2} = 0.2.$$

(b):



1' 1'

描点. 2'.
斜率 2'.
起始值. 2'.

(c): a Low-pass filter. 2' with a slope of -40 dB/decade at frequencies much greater than w_c = 5000 rad/s. Maximum gain: 0dB / 1 2'.

6.

(1). $\frac{V_{in} - V_o}{20 + R_L \| R_C} = \frac{V_o}{R_2}$.

$$H(w) = \frac{200}{20 + R_L \| R_C + 200} = \frac{200}{220 + \frac{200}{0.002jw + \frac{10^5}{jw}}}$$

$$= \frac{10}{11 + \frac{10jw}{10^5 - 2\times10^{-3}w^2}} = \frac{10^7 - 0.2w^2}{1.1\times10^7 - 0.22w^2 + 110jw}$$ 4'.

(2) $w \to 0$ $H(jw) \to \frac{10}{11}$

$w \to w_0$ $H(jw) \to 0$. ($w_0 = \sqrt{\frac{1}{LC}} = 7071.07$ rad/s, 即 resonant frequency).

$w \to \infty$ $H(jw) \to \frac{10}{11}$

Band-reject filter. 4'.

(3). $|H(jw)| = \frac{-200w^2 + 10^{10}}{\sqrt{(-220w^2 + 1.1\times10^{10})^2 + (10^5 w)^2}}$ $= \frac{10}{11} \times \frac{1}{\sqrt{2}}$ 2'.

Find w: ① when $w > 7071.07$ rad/s.

$w_{11} = -8847.45$ rad/s. < 0.

$w_{21} = 7301.99$ rad/s. ✓

② when $w < 7071.07$ rad/s.

$w_{12} = 6847.45$ rad/s ✓

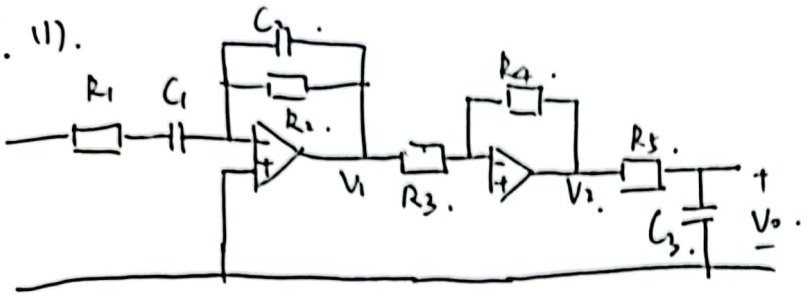
$w_{22} = -7301.99$ rad/s < 0

$B = w_{21} - w_{12}$. 2'.

$= 454.55$ rad/s.

1454.55). also right.

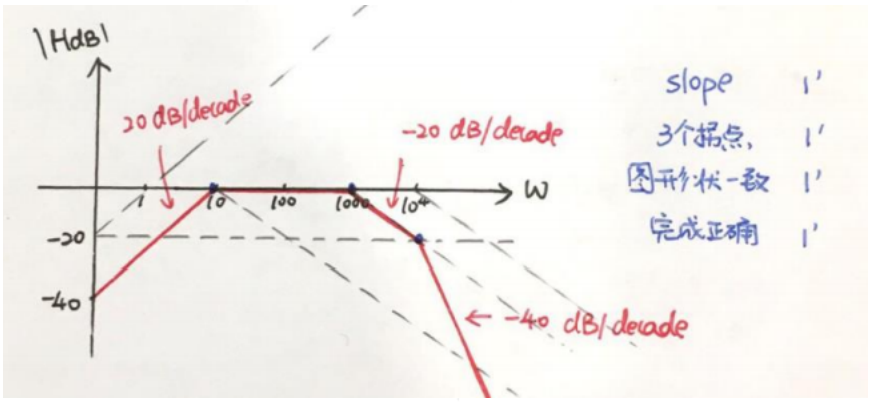
7. (1).



$$\begin{cases} \dfrac{V_{in}}{R_1 + 1/j\omega C_1} + \dfrac{V_1}{R_2} + \dfrac{V_1}{1/j\omega C_2} = 0. \\ \dfrac{V_1}{R_3} + \dfrac{V_2}{R_4} = 0. \quad 2' \\ \dfrac{V_2 - V_o}{R_5} = \dfrac{V_o}{1/j\omega C_3}. \end{cases} \Rightarrow H(j\omega) = \frac{V_o}{V_{in}} = \frac{0.1j\omega \cdot \quad 4'}{(1+\frac{j\omega}{10})(1+\frac{j\omega}{10^3})(1+\frac{j\omega}{10^4})}.$$

(2).

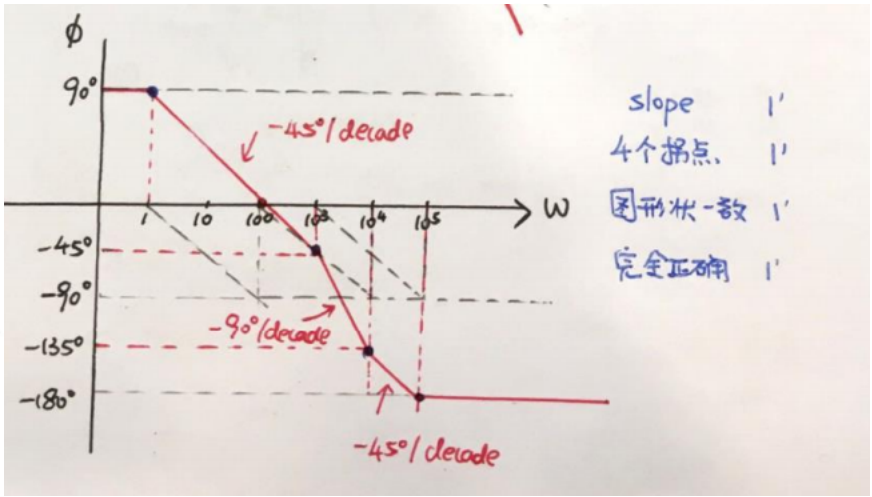
$|H|_{dB}$:



+整体趋势1'.

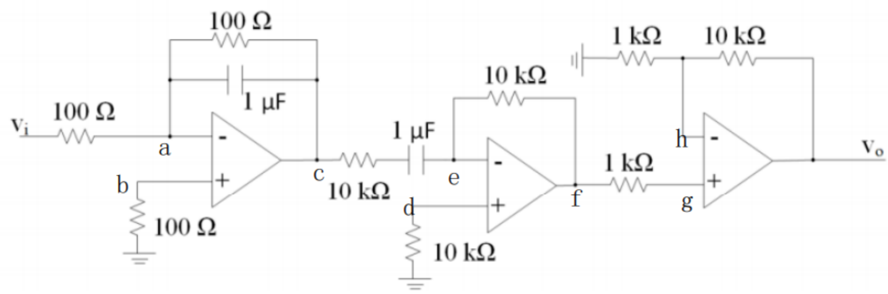
slope 1'
3个拐点, 1'
图形状一致 1'
完成正确 1'

ϕ:



slope 1'
4个拐点, 1'
图形状一致 1'
完全正确 1'

8:



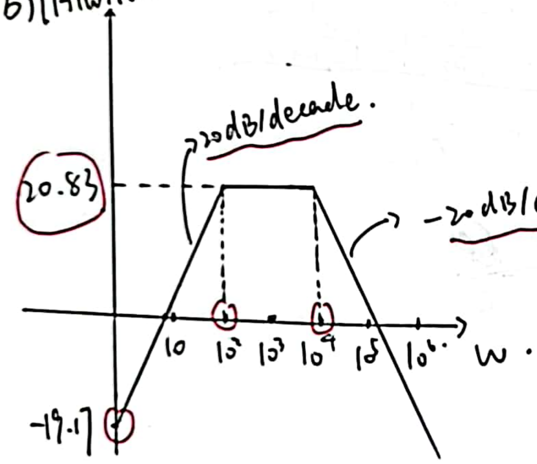
node a: $\dfrac{V_i}{100} + \dfrac{V_c}{100 \| (1/j\omega C)} = 0.$

node e: $\dfrac{V_c}{10000 + (1/j\omega C)} + \dfrac{V_f}{10000} = 0.$ 2'.

node h: $\dfrac{V_h}{1000} - \dfrac{V_o - V_h}{10000} = 0.$

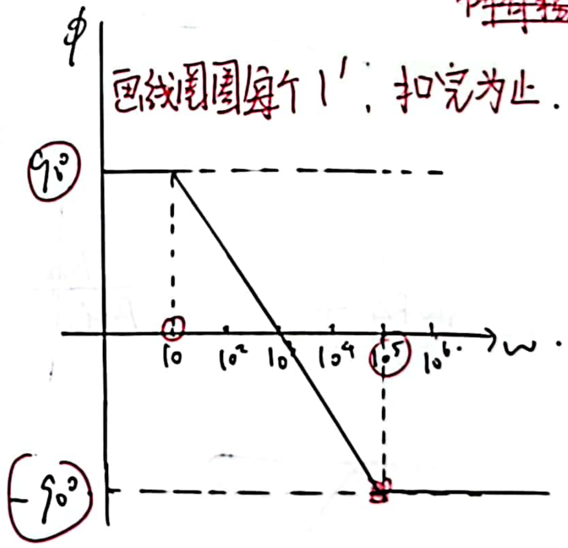
$H(\omega) = \dfrac{V_o}{V_i} = 0.11\, j\omega \left(1+\dfrac{j\omega}{100}\right)^{-1} \left(1+\dfrac{j\omega}{10^4}\right)^{-1}$ 4'.

(b) $|H(\omega)|_{dB}$.



~~所有标点每个1'~~.

曲线圆圈每个1'，扣完为止。共7'.



(c). Band-pass filter. 2'.