

## [专题七] 反馈

## 知识点1: 反馈组态判断

口诀: 记住:

电压/电流采样 → 输出端

串联/并联 → 输入端

## 知识点2: 反馈的良好性质

$$\textcircled{1} \frac{dA}{A} \xrightarrow{\text{减小}} \frac{dA_f}{A_f}$$

$$\frac{dA_f}{A_f} = \frac{1}{1+AF} \cdot \frac{dA}{A}$$

[P1-Ex.13] 解:  $\frac{dA}{A} = 0.2$  ①  $\frac{dA_f}{A_f} \leq 0.01$  ②  $|A_f| = 100$  ③

解: 先由 ①、② 结合  $\frac{dA_f}{A_f} = \frac{1}{1+AF} \cdot \frac{dA}{A}$

$$\Rightarrow \frac{1}{1+AF} \cdot 0.2 \leq 0.01 \quad \therefore \frac{1}{1+AF} \leq 0.05 \quad \textcircled{4} \Rightarrow 1+AF \geq 20 \quad \textcircled{5}$$

再由  $A_f = \frac{A}{1+AF}$  ⑥ 且  $A_f = 100 \Rightarrow A = 100(1+AF)$

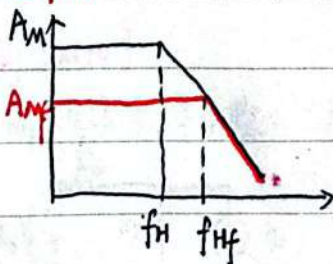
$$\therefore A \geq 2000 \quad \textcircled{7}$$

$$\therefore |A_v| > 2000$$

由 ⑤、⑦  $F \geq \frac{19}{2000} = 0.0095$  ⑧

## ② 增加带宽

如下图:



$$\text{高频段 } A(s) = \frac{A_m}{1 + \frac{s}{\omega_H}}$$

$$\text{引入反馈后: } A_{mf} = \frac{1}{1+A_{mf}} \cdot A_m \quad (\text{减小})$$

$$\omega_{Hf} = \omega_H (1+A_{mf}) \quad (\text{增加})$$

[P1: Ex. 12] A x

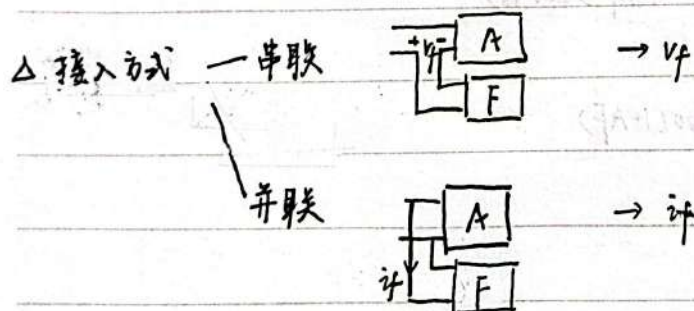
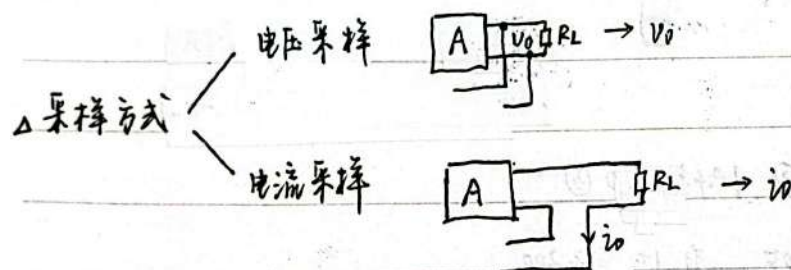
[P2: Ex. 7] 解:  $\frac{1}{1+AF} = \frac{1}{100}$   $f_H = (1+AF) f_H = 100 \cdot 10 \times 10^3 = 1 \times 10^6$ ;  $f = \frac{100}{100} = 1 \text{ Hz}$   
 $> 100 \text{ kHz}$

知识点: 求反馈系数

<步骤>: ① 找反馈回路, 标注正方向 (对照框图)  $\rightarrow$  <注>② 判断类型, 列表达式  $\rightarrow$  <注>  $F = \frac{V_f}{V_o}$ ③ 电压采样加  $I_0$  恒流源, 电压采样加  $V_0$  恒压源计算

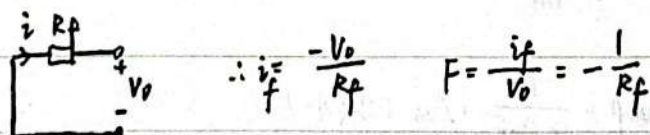
断开输入, 并联短接, 串联断路)

&lt;注: 表达式 &amp; 框图汇总&gt;

变形  $\rightarrow$  有些题求深度负反馈后  $A_v$ .即因  $A_v = \frac{1}{F}$ , 本题还是求  $F$ .

[P1: Ex. 5]

1) 电压并联负反馈:

短接  $A$ -与地, 加  $V_0$ 2) 电压串联负反馈:  $F = \frac{V_f}{V_0}$ , 断开  $V_f$  仅留  $V_f$ 

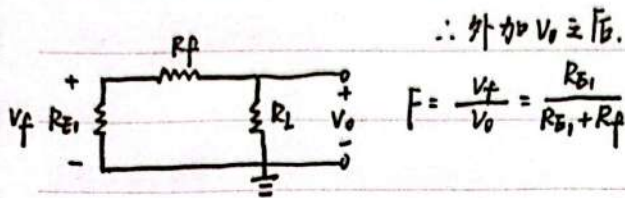
$$\frac{V_f}{V_0} = \frac{R_2}{R_1 + R_f}$$



## [P2-Ex. 2.12]

解: 类型: 电压采样串联  $F = \frac{V_f}{V_o}$ 

回路: 断后:

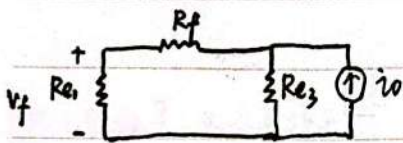


$$F = \frac{V_f}{V_o} = \frac{R_{E1}}{R_{E1} + R_f}$$

## [P2-Ex. 6.12]

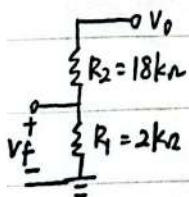
解: 电流采样串联  $F = \frac{V_f}{i_o}$ 

回路:

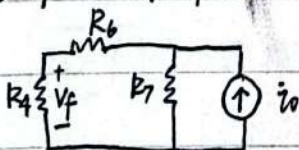


$$\therefore F = \frac{V_f}{-i_o} = \frac{R_{E3} + R_f}{R_{E1} + R_f + R_{E3}} \cdot R_{E3} \cdot \frac{R_{E1}}{R_{E1} + R_f} = \frac{-R_{E1} R_{E3}}{R_{E1} + R_{E3} + R_f}$$

## [P2-Ex. 9]

解: 电压采样串联  $F = \frac{V_f}{V_o} = \frac{2}{20} = 0.1$ 

## [P2-Ex. 10]

①  $V_{o1}$ : 电流采样串联:  $F = \frac{V_f}{i_o}$ 

$$\therefore \frac{V_f}{i_o} = -\frac{R_4 R_7}{R_4 + R_6 + R_7} = \frac{1}{3} k\Omega$$

②  $V_{o2}$ : 电压采样串联:  $F = \frac{V_f}{V_o} = \frac{R_4}{R_4 + R_6} = 0.4$

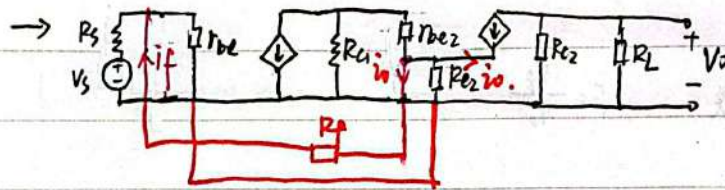
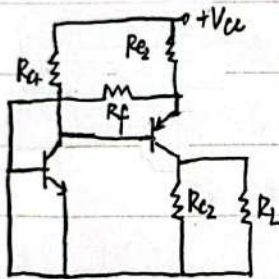
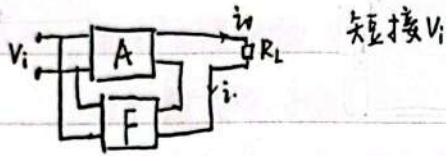
No.

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[P2-Ex.12]

电流采样并联:  $F = \frac{i_o}{i_f}$

画个框图:



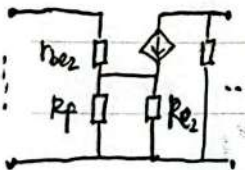
短接  $V_i$

$$\frac{i_f}{i_o} = \frac{R_{e2}}{R_f + R_{e2}}$$

$i_o$ : 接入点接后

$i_f$ : 短接  $V_i$

像上面画出模型效果更好.



知识点4: 深度负反馈下增益求解,  $R_{if}/R_{of}$

<建立在3的基础上, 不太难>

[P2-Ex.2(4)]

$$F = \frac{R_{E1}}{R_{E1} + R_f} = \frac{V_f}{V_o} \quad \text{电压采样串联}$$

$$A_v = \frac{V_o}{V_i} = \frac{1}{F} = \frac{R_{E1} + R_f}{R_E}$$

$$R_{if} = R_i (1 + AF) \rightarrow \infty$$

$$R_{of} = \frac{R_o}{1 + AF} \rightarrow 0$$

[P2-Ex.6(12)]

$$\text{电流采样串联, } F = \frac{V_f}{i_o} = - \frac{R_{e1} R_{e3}}{R_{e1} + R_{e3} + R_f}$$

$$\therefore A_{vf} = \frac{V_o}{V_i} = \frac{1}{F} \cdot R_o = - \frac{R_{e1} + R_{e3} + R_f}{R_{e1} R_{e3}} \cdot R_{o3}$$



[P2-Ex.9] 电压采样串联  $F = \frac{V_f}{V_o} = \frac{2}{20} = 0.1$

$$\therefore A_v = \frac{1}{F} = 10$$

$$R_{if} = R_i(1+AF) \rightarrow \infty$$

$$R_{of} = \frac{R_o}{1+AF} \rightarrow 0$$

[P2-Ex.10]

$V_{o1}$ : 电流采样串联  $F = \frac{V_f}{V_o} = \frac{1}{3}$

$$\therefore A_{vf} = \frac{1}{F} \cdot R_g = 3 \cdot 1 = 3 \text{ V/V}$$

$V_{o2}$ : 电压串联

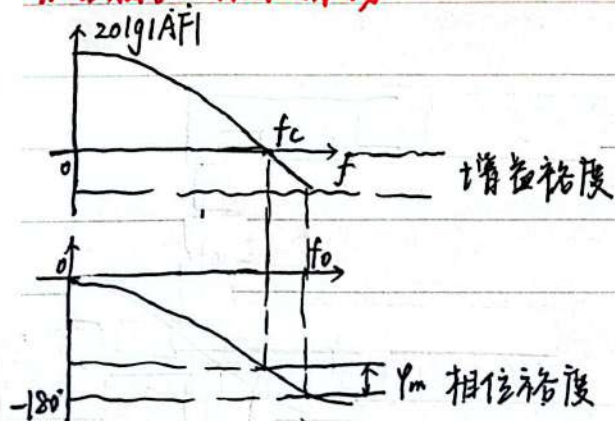
$$A_{vf} = \frac{1}{F} = 2.5 \text{ V/V}$$

[P2-Ex.12] 电流采样并联  $F = \frac{i_o}{i_f} = \frac{R_2}{R_f + R_2}$

$$\therefore A_{vf} = \frac{R_o}{R_f} \cdot \frac{R_f + R_2}{R_2}$$

$$= \frac{(R_2 \parallel R_L)}{R_f} \cdot \frac{R_f + R_2}{R_2}$$

知识点5: 自激振荡



$f_o > f_c$  电路稳定, 不自激振荡

[记忆时:  $f_c$  无机会到  $-180^\circ$ ]

[P2: Ex.4] 解:  $20 \lg |AF| \leq 0 \Rightarrow 20 \lg |A| + 20 \lg |F| \leq 0$

$f_o$  处,  $20 \lg |A| = 60 \text{ dB}$   $\therefore 20 \lg |F| \leq -60 \text{ dB}$   $\therefore$  上限  $-60 \text{ dB}$