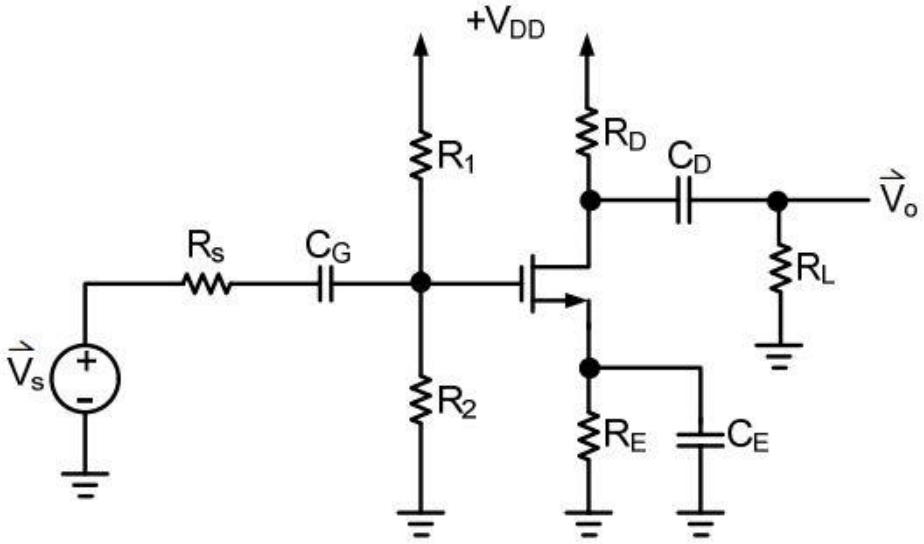
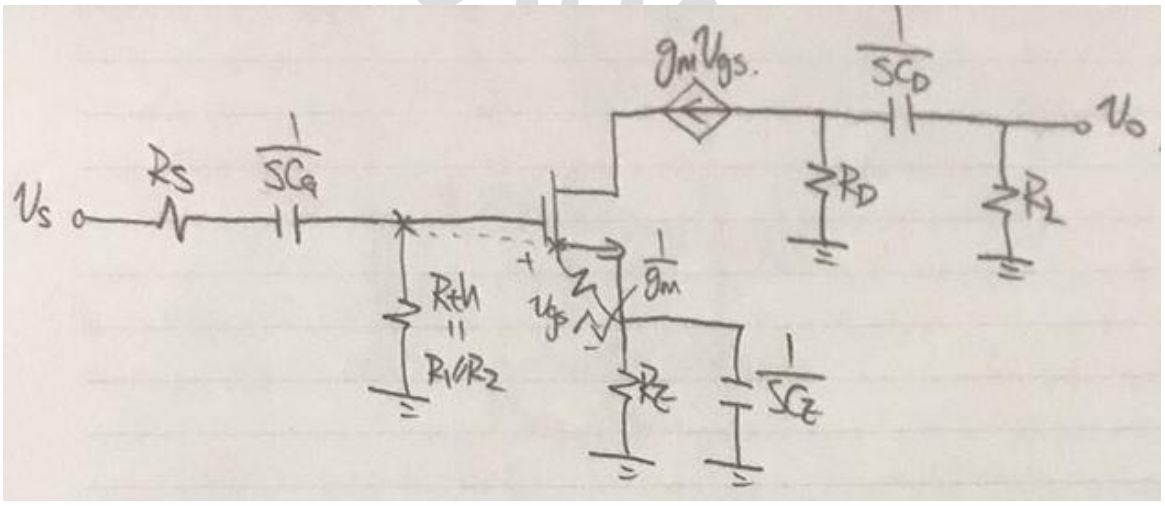
109 年公務人員特種考試警察人員、一般警察人員考試及 109 年特種考試交通事業鐵路人員考試試題

考試別：鐵路人員考試
等　別：員級考試
類科別：電力工程、電子工程
科　目：電子學概要

一、試求下圖電路之低頻電壓增益（包含三個極點）。（25 分）



【擬答】

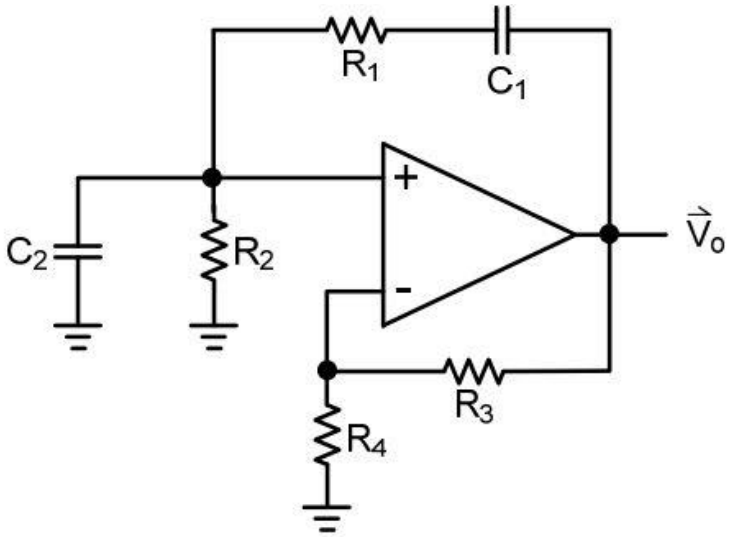


$$U_0 = -g_m U_{gs} \times \frac{R_D}{R_D + \frac{1}{SC_D} + R_L} \times R_L$$

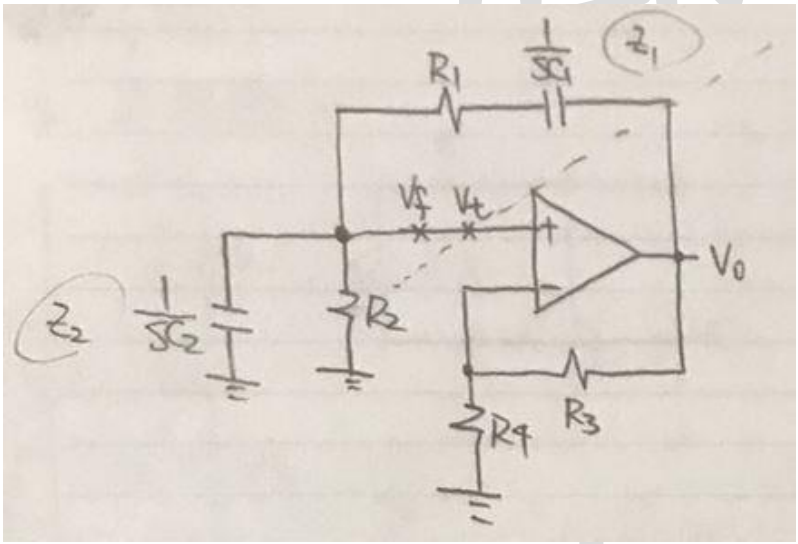
$$= -g_m \times \left(U_s \times \frac{R_{th}}{R_s + \frac{1}{SC_G} + R_{th}} \times \frac{\frac{1}{g_m}}{\frac{1}{g_m} + \left(R_E \,//\, \frac{1}{SC_E} \right)} \times \frac{R_D \times R_L}{R_D + \frac{1}{SC_D + R_L}} \right)$$

$$\Rightarrow \frac{U_0}{U_S} = -g_m \times \frac{R_{th}}{R_s + \frac{1}{SC_G} + R_{th}} \times \frac{\frac{1}{g_m}}{\frac{1}{g_m + \left(R_E \,''\, \frac{1}{SC_E}\right)}} \times \frac{R_D \times R_L}{R_D + \frac{1}{SC_D} + R_L}$$

二、試求下圖電路之震盪條件及震盪頻率。（25 分）



【擬答】



$$A = \frac{V_o}{Vt} = 1 + \frac{R_3}{R_4}$$

$$B = \frac{U_f}{U_0} = \frac{Z_2}{Z_1 + Z_2} = \frac{1}{1 + Z_1 Y_2} = \frac{1}{1 + \left(R_1 + \frac{1}{SC_1}\right)\left(\frac{1}{R_2 + SC_2}\right)} = \frac{1}{1 + \frac{R_1}{R_2} + \frac{C_2}{C_1} + SR_1C_2 + \frac{1}{SR_2C_1}}$$

$$L_{(S)} = B \cdot A = \frac{1 + \frac{R_3}{R_4}}{1 + \frac{R_1}{R_2} + \frac{C_2}{C_1} + SR_1C_2 + \frac{1}{SR_2C_1}}$$

$$\Rightarrow L_{(jw)} = \frac{1 + \frac{R_3}{R_4}}{\left(1 + \frac{R_1}{R_2} + \frac{C_2}{C_1}\right) + j\left(wR_1C_2 - \frac{1}{WR_2C_1}\right)}$$

$$|BA| \geq 1$$

震盪條件:令 $\Rightarrow \left| \dfrac{1+\dfrac{R_3}{R_4}}{1+\dfrac{R_1}{R_2}+\dfrac{C_2}{C_1}} \right| \geq 1 \Rightarrow \dfrac{R_3}{R_4} \geq \dfrac{R_1}{R_2}+\dfrac{C_2}{C_1}$

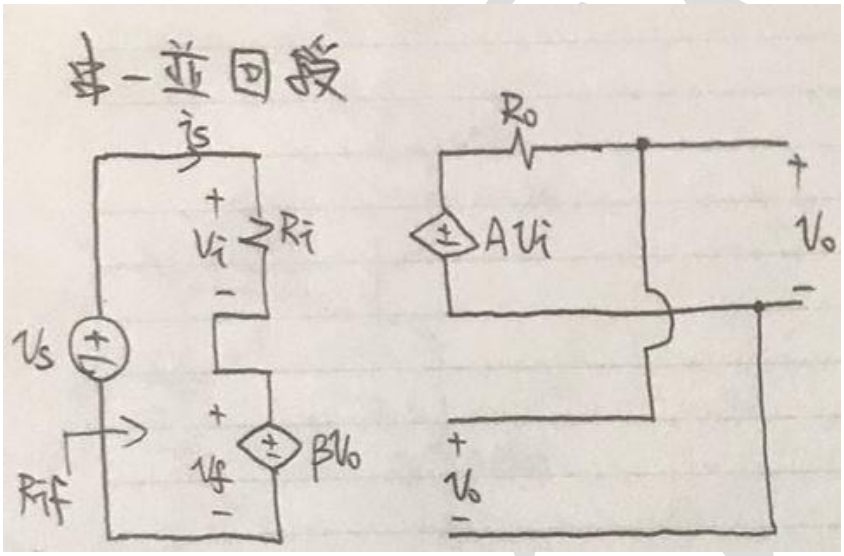
震盪頻率:令處部為 0

$$\Rightarrow WR_1C_2 - \frac{1}{WR_2C_1} = 0$$

$$\Rightarrow W = \frac{1}{\sqrt{R_1C_1R_2C_2}}(\text{rad/s})$$

三、試畫出串聯及並聯式回授放大器電路之結構圖，並求出其輸入電阻及輸 出電阻。（25 分）

【擬答】

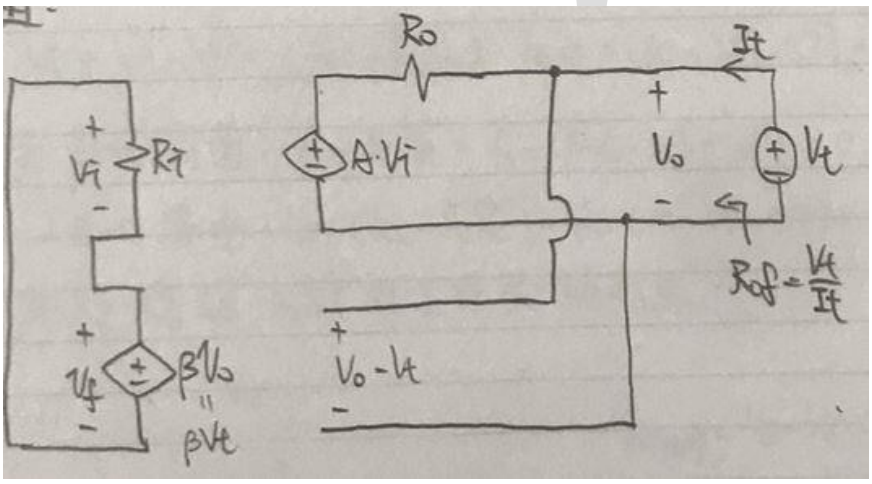


輸入電阻

$$R_if = \frac{U_s}{i_S} = \frac{U_1+U_f}{i_S} = \frac{i_SR_i+BV_o}{i_S} = \frac{i_SR_i+BAU_i}{i_S} = \frac{i_SR_i+BAiR_i}{i_S}$$

$$\Rightarrow R_if = (1+BA)R_i$$

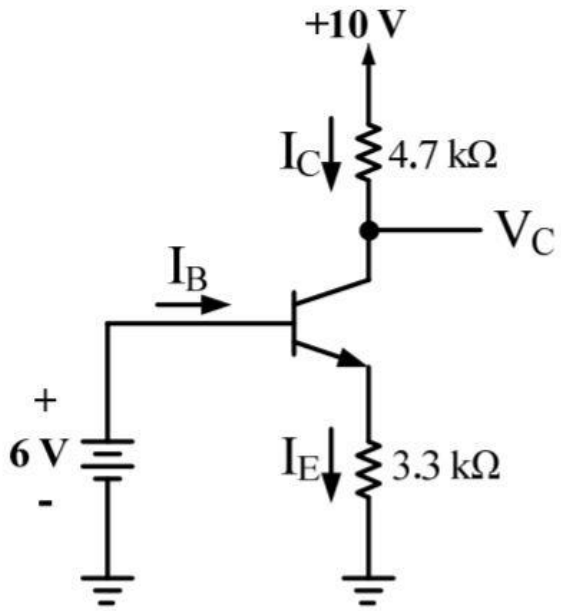
輸出電阻



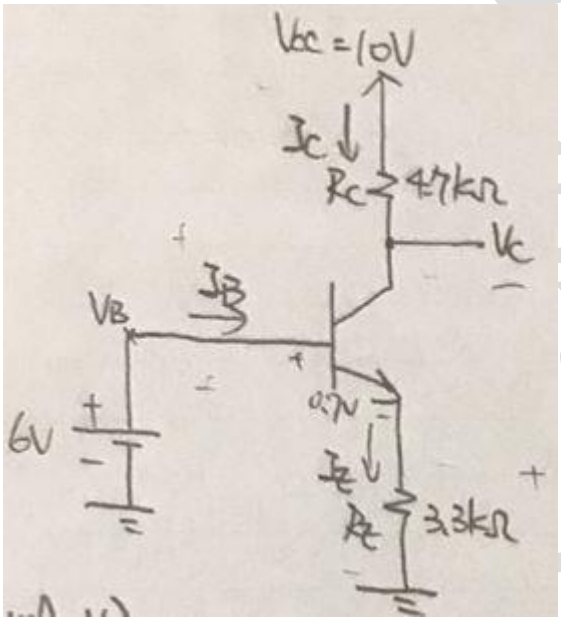
$$R_of = \frac{V_t}{I_t} = \frac{V_t}{\frac{V_t - AV_i}{R_o}} = R_o \cdot \frac{V_t}{V_t - AV_i} = R_o \cdot \frac{V_t}{V_t - A(-BV_t)}$$

$$\Rightarrow R_o\delta = \frac{R_0}{1+BA}$$

四、假設β=100，試進行下圖電晶體電路之直流分析。（25 分）



【擬答】



假設 BJT 工作於作用區

$$I_E=\frac{V_B-0.7}{R_E}=\frac{6-0.7}{3.3}=1.606mA$$

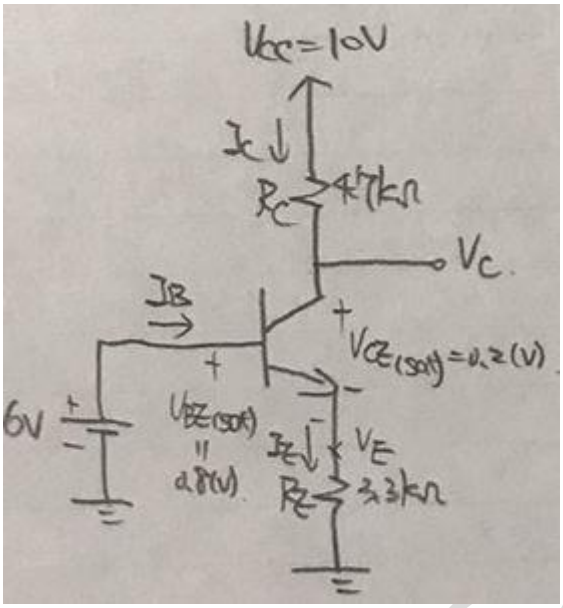
$$I_C=\alpha\cdot I_E=\frac{\beta}{H\beta}I_E=1.606=1.59mA$$

$$V_{CE}=V_C-V_E=(V_{CC}-I_CR_C)-I_ER_E=(10-1.59\times4.7)-1.606\times3.3=-2.77(V)$$

而B-E接面：$6-I_ER_E=6-1.606\times3.3=0.720$

B-C接面：$6-(V_{CC}-I_CR_C)=6-(10-1.59\times47)=3.47>0$

則假設錯誤，BJT 工作於飽和區



$V_{BE(sat)} = V_B - V_E = 0.8(V)$

$\Rightarrow 6 - V_E = 0.8 \Rightarrow V_E = 5.2(V)$

$V_{CE(sat)} = V_C - V_E = 0.2(V)$

$\Rightarrow V_C - 5.2 = 0.2 \Rightarrow V_C = 5.4(V)$

$$I_{C(sat)} = \frac{V_{CC} - V_C}{R_C} = \frac{10 - 5.4}{4.7} = 0.979mA$$

$$I_{E(sat)} = \frac{V_E}{R_E} = \frac{5.2}{3.3} = 1.576mA$$

$$I_{B(sat)} = I_{E(sat)} - I_{C(soc)} = 1.576 - 0.979 = 0.597mA$$

則
$$\begin{cases} I_B = 0.597mA \\ I_C = 0.979mA \\ I_E = 1.576mA \\ V_C = 5.4VmA \end{cases}$$