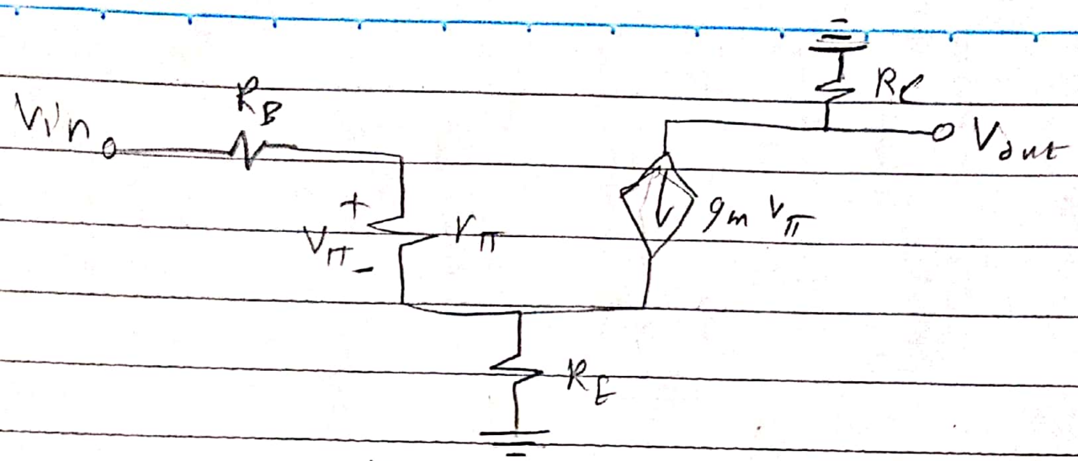
No
Date

1



$$V_{out} = -g_m V_\pi R_C$$

$$V_\pi = V_{in} - R_E\left(g_m V_\pi + \frac{V_\pi}{r_\pi}\right) - \frac{V_\pi}{r_\pi} R_B$$

$$V_\pi \left(1 + R_E\left(\frac{1}{r_\pi} + g_m\right) + \frac{R_B}{r_\pi}\right) = V_{in}$$

$$V_\pi = V_{in}\left(\frac{1}{1 + R_E\left(\frac{1}{r_\pi} + g_m\right) + \frac{R_B}{r_\pi}}\right)$$

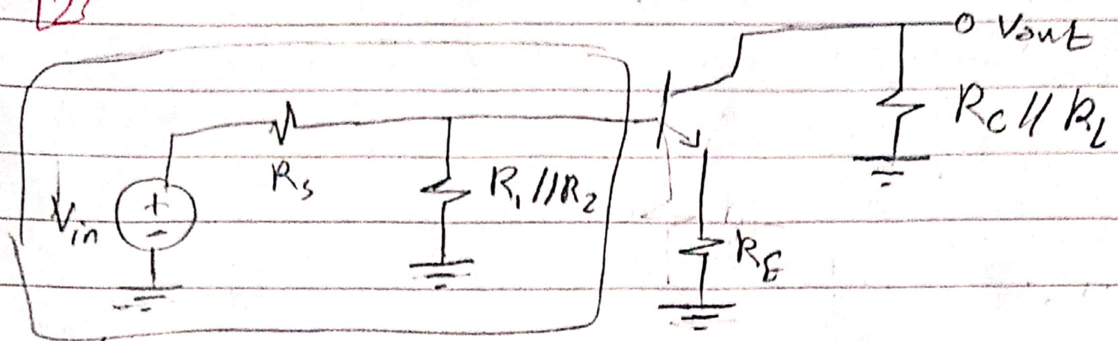
$$A_v = \frac{-R_C}{\frac{1}{g_m} + R_E\left(\frac{\beta+1}{\beta}\right) + \frac{R_B}{\beta}}$$

since $\beta \gg 1$

$\beta + 1 \approx \beta$

$$\approx \frac{-R_C}{\frac{1}{g_m} + R_E + \frac{R_B}{\beta+1}}$$

2



$$R_{th} = R_1 \parallel R_2 \parallel R_s$$

$$V_{th} = \frac{R_1 \parallel R_2}{R_1 \parallel R_2 + R_s} V_{in}$$

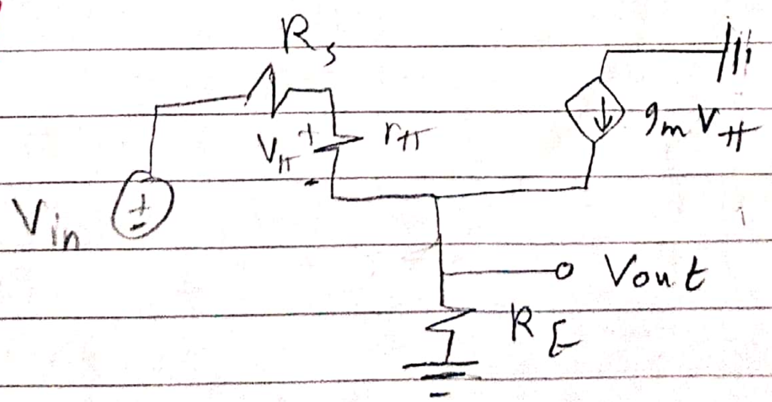
using the equations from problem 1

$$V_{out} = -g_m V_\pi (R_C \parallel R_L)$$

$$V_\pi = \frac{R_1 \parallel R_2}{R_1 \parallel R_2 + R_s} V_{in} \left(\frac{1}{1 + R_E\left(\frac{1}{r_\pi} + g_m\right) + \frac{R_{th}}{r_\pi}} \right)$$

$$A_V = \frac{-R_C \parallel R_L}{\frac{1}{g_m} + R_E + \frac{R_1 \parallel R_2 \parallel R_s}{\beta + 1}} \cdot \frac{R_1 \parallel R_2}{R_1 \parallel R_2 + R_s}$$

3



$$V_{out} = V_\pi \left(R_E \left(g_m + \frac{1}{r_\pi} \right) \right)$$

$$V_{in} - V_{out} = V_\pi \left(\frac{r_\pi + R_s}{r_\pi} \right)$$

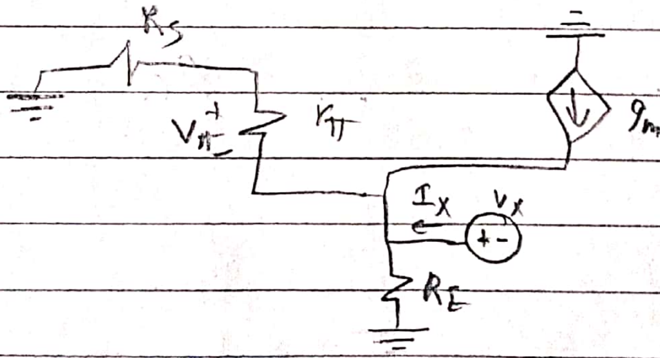
$$V_\pi = (V_{in} - V_{out}) \left(\frac{r_\pi}{r_\pi + R_s} \right)$$

$$V_{out} \left(1 + \frac{\cancel{r_\pi}}{r_\pi + R_s} \cdot \frac{R_E \beta}{r_\pi} \right) = V_{in} \frac{R_E \beta}{r_\pi + R_s}$$

$$A_v = \frac{R_E \beta}{r_\pi + R_s} \cdot \frac{1}{1 + \frac{R_E \beta}{r_\pi + R_s}} = \frac{1}{1 + \frac{r_\pi + R_s}{R_E \beta}}$$

$$= \frac{1}{1 + \frac{1}{R_E g_m} + \frac{R_s}{R_E \beta}} \approx \frac{R_E}{R_E + \frac{1}{g_m} + \frac{R_s}{\beta + 1}}$$

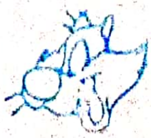
$\boxed{A}$



$$g_m V_\pi + \frac{V_\pi}{r_\pi} + I_x = \frac{V_x}{R_E}$$

$$V_\pi = -V_x - \frac{V_\pi}{r_\pi} R_s \quad \rightarrow \quad V_\pi \left(1 + \frac{R_s}{r_\pi} \right) = -V_x$$

$$V_\pi = -V_x \left(\frac{r_\pi}{R_s + r_\pi} \right)$$



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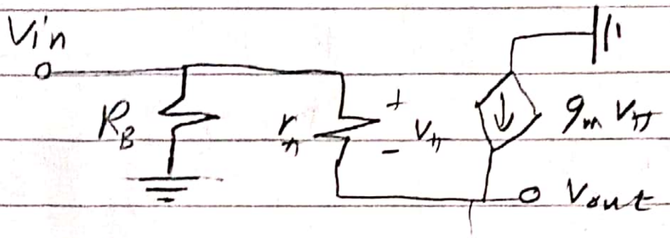
$$-V_x g_m \left(\frac{r_\pi}{R_s + r_\pi} \right) + \frac{-V_x}{R_s + r_\pi} + I_x = \frac{V_x}{R_E}$$

$$I_x = V_x \left(\frac{1}{R_E} + \frac{\beta+1}{R_s + r_\pi} \right)$$

$$R_{out} = \left(\frac{1}{R_E} + \left(\frac{R_s}{\beta+1} + \frac{r_\pi}{\beta+1} \right)^{-1} \right)^{-1} = R_E // \left(\frac{R_s}{\beta+1} + \frac{1}{g_m} \right)$$

5

Av

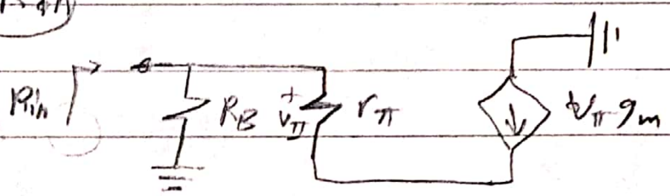


$$V_\pi = V_{in} - V_{out}$$

$$\frac{V_\pi}{r_\pi} = -g_m V_\pi \rightarrow V_\pi \left(\frac{1}{r_\pi} + g_m \right) = 0 \rightarrow V_\pi = 0$$

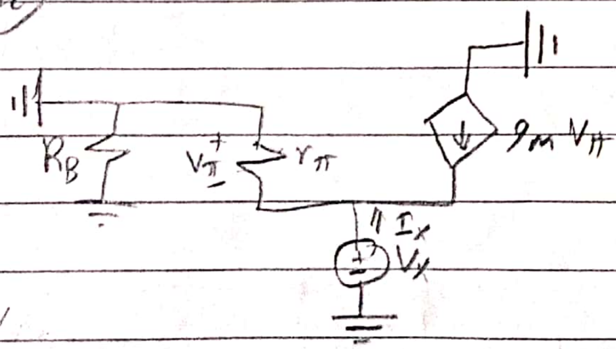
$$V_{in} - V_{out} = 0 \qquad A_v = \frac{V_{out}}{V_{in}} = 1$$

Rin



$$R_{in} = R_B$$

Rout



$$V_x = -V_\pi$$

$$I_x + g_m V_\pi + \frac{V_\pi}{r_\pi} = 0$$

$$I_x - g_m V_x - \frac{V_x}{r_\pi} = 0$$

$$I_x = V_x \left(g_m + \frac{1}{r_\pi} \right)$$

$$R_{out} = \frac{V_x}{I_x} = \frac{1}{g_m + \frac{1}{r_\pi}} \simeq \frac{1}{g_m}$$

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