HW8

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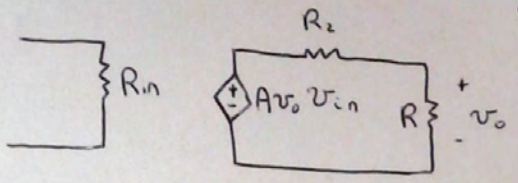
Problem 1:

a) b)



100/100

* For $R = 33k\Omega$

$$v_o = \frac{33}{33 + R_2} A_{v_0} v_{in}$$

$$\frac{v_o}{v_{in}} = \frac{33}{33 + R_2} A_{v_0} = 99$$

* For $R = 39k\Omega$,

$$\frac{v_o}{v_{in}} = \frac{39}{39 + R_2} A_{v_0} = 108$$

$$\begin{cases} 33 A_{v_0} = 99(33 + R_2) \\ 39 A_{v_0} = 108(39 + R_2) \end{cases}$$

Solving these 2 equations with 2 unknowns we get:

$A_{v_0} = 216$ V/V

$R_2 = 39$ kΩ

c) With 47 kΩ resistance,

$$v_{in} = \frac{R_{in}}{R_{in} + 47} v_{sig} = 0.76\, v_{sig}$$

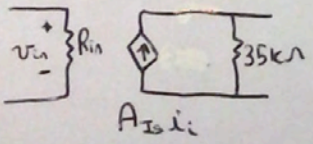
$$\Rightarrow R_{in} = 0.76(R_{in} + 47)$$

$$R_{in}(1 - 0.76) = 47 \times 0.76$$

$R_{in} = 148.83$ kΩ

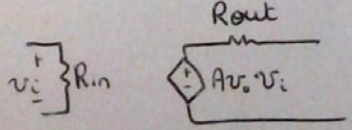
Problem 2:

$R_{in} = 150$ kΩ $\quad A_{is} = 200$ A/A

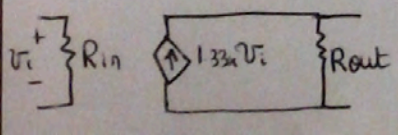


$$A_{v_0} = G_m R_{out} = \frac{A_{is}}{R_{in}} \times R_{out} = 46.67 \text{ V/V}$$

$$G_m = \frac{A_{v_0}}{R_o} = \frac{46.67}{35} = 1.33 \text{ mA/V}$$

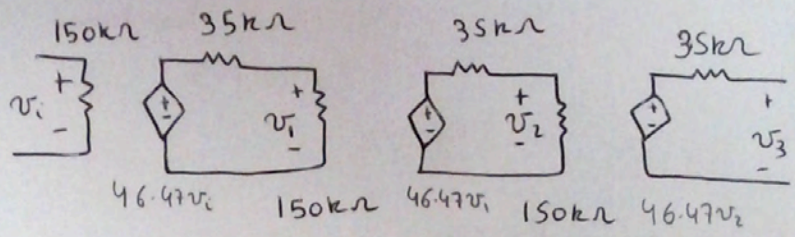


$A_{v_0} = 46.67$ V/V



$G_m = 1.33$ mA/V

b)



$$R_{in} = \frac{v_i}{i_i} = 150k\Omega$$

$$R_{out} = \frac{V_x}{i_x}\Big|_{v_{in}=0} = 35k\Omega \quad (V_x \text{ and } i_x \text{ are test voltage and current})$$

$$v_1 = \frac{150}{150+35} \times 46.47 v_i \Rightarrow A_{v_1} = \frac{v_1}{v_{in}} = 36.68\ V/V$$

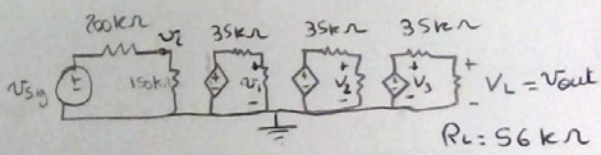
$$v_2 = \frac{150}{150+35} \times 46.47 v_1 \Rightarrow A_{v_2} = 36.68\ V/V$$

$$v_3 = 46.47\, v_2 \Rightarrow A_{v_3} = 46.47$$

$$A_{v_o} = \frac{v_{out}}{v_{in}} = \frac{v_3}{v_i} = \frac{v_3}{v_2} \times \frac{v_2}{v_1} \times \frac{v_1}{v_i} = A_{v_3} \times A_{v_2} \times A_{v_1} = 65971\ V/V$$

$$A_{is} = \frac{R_{in}}{R_{out}} A_{v_o} = 282732\ A/A$$

$$G_m = \frac{A_{v_o}}{R_{out}} = 1.88\ A/V$$



c) $v_o = V_L = \frac{56}{56+35} \times v_3 = 28.6\, v_2$

$$v_i = \frac{150}{150+200} v_{sig} = 0.428\, v_{sig}$$

$$\frac{v_{out}}{v_i} = \frac{v_{out}}{v_3} \times \frac{v_3}{v_2} \times \frac{v_2}{v_1} \times \frac{v_1}{v_i} = 0.614\, A_{v_o} = 40597\ V/V$$

$$\frac{v_{out}}{v_{sig}} = \frac{v_{out}}{v_i} \times \frac{v_i}{v_{sig}} = 17399\ V/V \quad \text{in dB, } \frac{v_{out}}{v_{sig}} = 84.8\ dB$$

$$\frac{i_{out}}{i_{sig}} = \frac{v_{out}/R_L}{v_{sig}/(R_{in}+R_{sig})} = \frac{v_{out}}{v_{sig}} \times \frac{150+200}{56} = 108743\ A/A$$

in dB, $A_i = 20\log(A_{i(A/A)}) = 100\ dB$

$$A_p = \frac{v_{out}}{v_{sig}} \times \frac{i_{out}}{i_{sig}} = 1.89 \times 10^9\ W/W$$

in dB, $A_p = 10\log A_{p(W/W)} = 92.77\ dB$