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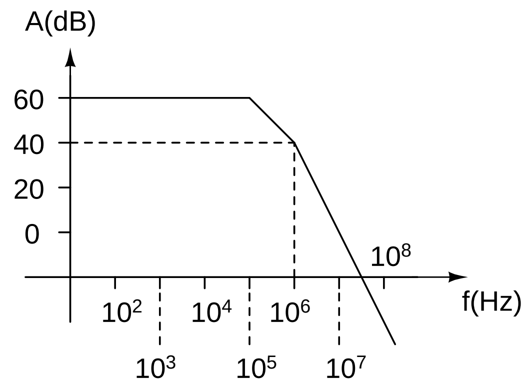
Electronics II - INEL 4202 - Fall 2001
Solutions to Exam 2

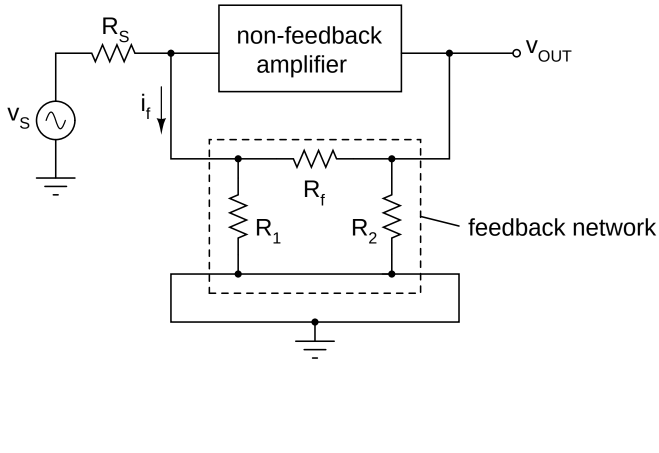
1. The magnitude Bode plot of a non-feedback amplifier that will be used in a feedback configuration is shown below. The feedback amplifier will have an approximate low-frequency gain of 20dB. Compensate the amplifier to have a 45° phase margin using (a) the pole-shifting method, and (b) the pole-addition method. (10 points each)



ANSWER: (a) The gain at the second pole is 40 dB. Since a feedback amplifier gain of $A_f \approx 1/\beta = 20$ dB is desired, the gain at the second pole should be reduced by 20 dB. This can be accomplished by moving the first pole down by one decade to 10^4 Hz.

(b) Since we are adding a pole, the original first pole will become the second. The gain at the original first pole is 60 dB and thus should be reduced by 40 dB. Therefore the new pole should be added two decades below 10^5 Hz, i.e. at 10^3 Hz.

2. The voltage-sampling, current-mixing feedback amplifier sketched below uses $R_1 = R_2 = 100\Omega$ and $R_f = 10k\Omega$. The source's Thevenin resistance is $R_s = 500\Omega$.



(a) Find R_{11}, R_{22} and the feedback network's β. (10 points each)

ANSWER: From the table:

$$R_{11} = \frac{v_1}{i_1} \mid_{v_2=0} = R_1 \mid\mid R_f \approx 99\Omega$$

$$R_{22} = \frac{v_2}{i_2} \mid_{v_1=0} = R_1 \mid\mid R_f \approx 99\Omega$$

$$\beta = y_{12} = \frac{i_1}{v_2} \mid_{v_1=0} = -\frac{1}{R_f} = -10^{-4} A/V$$

(b) Determine the feedback amplifier's voltage gain if the non-feedback amplifier voltage gain $A_v = \frac{v_{OUT}}{v_s}$ has been properly calculated and found to be -1000V/V. Use the β you found in (a), or $\beta = -10^{-4} A/V$. (15 points)

ANSWER:

$$R_m = \frac{v_{out}}{i_s} = \frac{v_{out}}{v_s/R_s} = R_s A_v = 500\Omega \times -1000V/V = -500k\Omega$$

$$R_{mf} = \frac{R_m}{1+\beta R_m} = \frac{-500k\Omega}{1 + -500k\Omega \times -10^{-4} A/V} = \frac{-500k\Omega}{51} = -9.8k\Omega$$

Finally,

$$A_{vf} = \frac{R_{mf}}{R_s} = \frac{-9.8k\Omega}{500\Omega} = -19.6V/V$$

(c) Estimate the non-feedback amplifier voltage gain if the feedback amplifier has an input resistance of $R_{if} = 10\Omega$, the non-feedback amplifier has an input resistance $R_i = 100\Omega$ and the feedback network's $\beta = -10^{-2}$ A/V. (15 points)

ANSWER:

$$D = \frac{R_i}{R_{if}} = \frac{100}{10} = 10 = 1 + \beta R_M$$

$$R_M = \frac{v_O}{i_s} = \frac{v_O}{v_s/R_s} = \frac{9}{-10^{-2} A/V} = -900\Omega$$

$$A_v = \frac{v_O}{v_s} = \frac{R_M}{R_s} = -\frac{900\Omega}{500\Omega} = -1.8V/V$$

3. A non-feedback amplifier with gain $A_{nf} = 1000V/V$ is used in a voltage-sampling, voltage-mixing feedback configuration.

(a) Determine the feedback's network β if the feedback's amplifier gain is $25V/V$. (10 points)
ANSWER:

$$1 + \beta A_{nf} = \frac{A_{nf}}{A_f} = \frac{1000}{25} = 40$$

$$\beta = \frac{40 - 1}{1000} = 0.039V/V$$

(b) Find the feedback's amplifier gain if the feedback amplifier's temperature sensitivity is 10 % of the non-feedback amplifier's. (10 points)
ANSWER:

$$D = \frac{S^T_{A_{nf}}}{S^T_{A_f}} = 10$$

$$A_f = \frac{A_{nf}}{D} = \frac{1000V/V}{10} = 100V/V$$