EE304 – Problem Set 5

Problem 11.3 [S&S 7/e]

11.3 The noninverting buffer op-amp configuration shown in Fig. P11.3 provides a direct implementation of the feedback loop of Fig. 11.1. Assuming that the op amp has infinite input resistance and zero output resistance, what is β? If $A = 1000$, what is the closed-loop voltage gain? What is the amount of feedback (in dB)? For $V_s = 1$ V, find V_o and V_i. If A decreases by 10%, what is the corresponding percentage decrease in A_f?

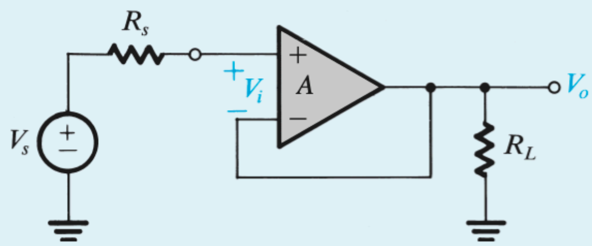

Figure P11.3

Problem 11.10 [S&S 7/e]

11.10 For the negative-feedback loop of Fig. 11.1, find the loop gain $A\beta$ for which the sensitivity of closed-loop gain to open-loop gain [i.e., $(dA_f/A_f)/(dA/A)$] is –40 dB. For what value of $A\beta$ does the sensitivity become 1/5?

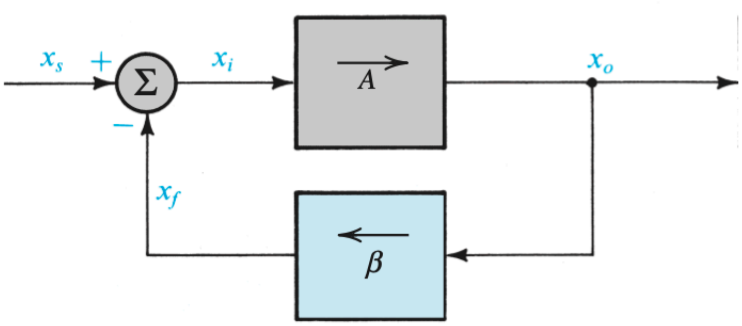

Figure 11.1 General structure of the feedback amplifier. This is a signal-flow diagram, and the quantities x represent either voltage or current signals.

Problem 11.27 [S&S 7/e]

D 11.27 Consider the series–shunt feedback amplifier in Fig. 11.11(a), which is analyzed in Example 11.3.

(a) If $R_1 = 10\ \text{k}\Omega$, find the value of R_2 that results in an ideal closed-loop gain of 10.

(b) Use the expression for $A\beta$ derived in Example 11.3 to find the value of the loop gain for the case $\mu = 1000$, $R_{id} = 100\ \text{k}\Omega$, $r_o = 1\ \text{k}\Omega$, $R_s = 100\ \text{k}\Omega$, and $R_L = 10\ \text{k}\Omega$. Hence determine the value of the closed-loop gain A_f.

(c) By what factor must μ be increased to ensure that A_f is within 1% of the ideal value of 10?

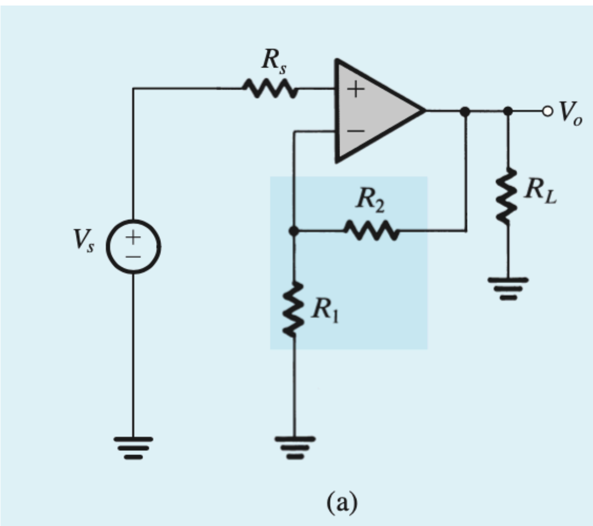

Figure 11.11 Example 11.3. (**a**) A series–shunt feedback amplifier;

Expression of Aβ *derived in Example 11.3:*

$A\beta \equiv -V_r/V_t$ involves repeated application of the voltage divider rule, resulting in

$$A\beta = \mu \frac{\{R_L \,\|\, [R_2 + R_1 \,\|\, (R_{id} + R_s)]\}}{\{R_L \,\|\, [R_2 + R_1 \,\|\, (R_{id} + R_s)]\} + r_o} \times \frac{[R_1 \,\|\, (R_{id} + R_s)]}{[R_1 \,\|\, (R_{id} + R_s)] + R_2} \times \frac{R_{id}}{R_{id} + R_s}$$

Problem 11.83 [S&S 7/e]

11.83 An op amp designed to have a low-frequency gain of 10^5 and a high-frequency response dominated by a single pole at 100 rad/s acquires, through a manufacturing error, a pair of additional poles at 20,000 rad/s. At what frequency does the total phase shift reach 180°? At this frequency, for what value of β, assumed to be frequency independent, does the loop gain reach a value of unity? What is the corresponding value of closed-loop gain at low frequencies?

Problem 11.86 [S&S 7/e]

11.86 Consider a feedback amplifier for which the open-loop gain $A(s)$ is given by

$$A(s) = \frac{10,000}{\left(1+s/10^4\right)\left(1+s/10^5\right)^2}$$

If the feedback factor β is independent of frequency, find the frequency at which the phase shift is 180°, and find the critical value of β at which oscillation will commence.