EE324 LAB 9

Feedback effects on bandwidth and stability: the root locus and the Nyquist stability criterion. In this lab, you will observe how the use of feedback influences the stability and the bandwidth of an amplifier. You will analyze the root locus and you will verify the Nyquist stability criterion.

Lab Assignment

1. An operational amplifier (Op-Amp) has the following transfer function (in Laplace representation) from the differential voltage $V_p - V_n$ to the output voltage V_o:

$$A(s) = \frac{10^4}{(1 + 10^{-4}s)(1 + 4 \cdot 10^{-4}s)(1 + 10^{-6}s)}$$

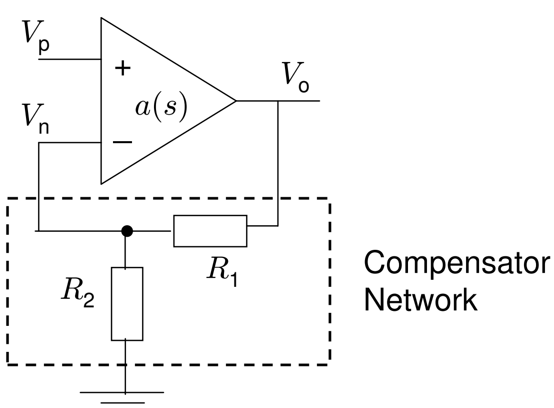

Figure 1: The Op-Amp with the static compensator

2. The Op-Amp is compensated by the resistive network shown in Figure 1, where $R_1 = 9k\Omega$, and $R_2 = 10\Omega$.

3. Compute the open-loop and closed-loop transfer functions of the compensated amplifier $L(s)$ and $T(s)$, respectively, and sketch (by hand) the root locus. To do this, you may first draw the the asymptotes corresponding to the branches of the root locus.

   For computing the transfer functions, you may assume that the output voltage V_o is not affected by the load provided by the compensator network, and that the current flowing into the (-) terminal of the Op-Amp is zero.

4. Verify your results by using the Matlab function `rlocus`.

5. Using the Matlab function `rlocfind`, find the value R_2^* of R_2 where the system is on the verge of instability.

6. What would happen if R_2 were increased beyond R_2^*?

For each of the values of $R_2 \in \{10\Omega, R_2^*, 1k\Omega\}$:

7. Represent the Bode plot of the open-loop transfer function $L(s)$ and compute its phase margin. Given the phase margin, comment on the stability of the closed-loop system $T(s)$.

8. Represent the Bode plot of the closed-loop transfer function $T(s)$ and evaluate the system bandwidth.

9. Represent the Nyquist diagram of the open-loop transfer function $L(s)$. Verify whether $L(s)$ has poles in the right half-plane and comment on the stability of the closed-loop system $T(s)$. You may use the Matlab function `nyquist`.

10. Map the poles of $T(s)$ on the complex s-plane and comment on the stability of $T(s)$. You may use the Matlab function `pzmap`.

11. Represent the step response of the closed-loop system $T(s)$ and comment on the system's stability.