Solution Proposal for Laboratory 10:

Problem 21:

Computation for $G_1(s)$

We get $G_1(0) = 0.25$ and we find the magnitude and phase for $\omega \to \pm\infty$ as follows.

- $\omega \to \infty$: Magnitude is 0 and phase goes to $-\pi/2$
- $\omega \to -\infty$: Magnitude is 0 and phase goes to $\pi/2$

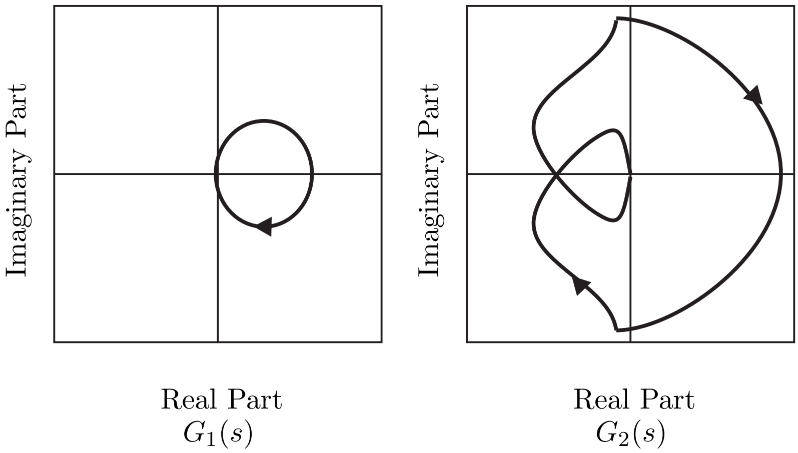
Since there is no pole of $G_1(s)$ on the imaginary axis, we do not have to close a small semi-circle

Computation for $G_2(s)$

We find the magnitude and phase for $\omega \to \pm\infty$ and $\omega \to 0$ as follows.

- $\omega \to 0$: Magnitude goes to ∞ and phase goes to $\pm\pi/2$ (one pole at $s = 0$)
- $\omega \to \infty$: Magnitude is 0 and phase goes to $-\pi$ (relative degree $r = 2$)
- $\omega \to -\infty$: Magnitude is 0 and phase goes to $-3\pi/2$ (relative degree $r = 3$)

For the pole at $s = 0$ we use the small semi-circle $re^{j\varphi}$ and find that it maps to the large circle $G_2(re^{j\varphi}) \approx \frac{4}{10 \cdot 20} \cdot \frac{1}{r} e^{-j\varphi}$ that closes from phase $\pi/2$ over phase 0 to phase $-\pi/2$ (clockwise)



Problem 22:

a. We get the following mapping:

$G_{o1}(s)$ belongs to plot "b". This can be seen from the fact that for $\omega \to 0$, the phase goes to $-\pi$.

$G_{o2}(s)$ belongs to plot "c". This can be seen from the fact that for $\omega \to 0$, the phase goes to $-\pi/2$ and for $\omega \to \infty$, the phase goes to 0 and the magnitude is larger than 0.

$G_{o3}(s)$ belongs to plot "a". This can be seen from the fact that for $\omega \to 0$, the phase goes to $\pi/2$ ($\frac{20}{-10j} = 2j$ has a phase of $\pi/2$)

b. See the Matlab/Simulink solution.

Problem 23:

a. See the Matlab/Simulink solution.

b. You should observe that the Bode plot and Nyquist plot contain the same information. In the Bode plot, you can see exact frequencies and in the Nyquist plot you see the relation of magnitude/phase better.