ECEN 620

Homework #1

Due: 9-12-2023, 11:59PM Homeworks will not be received after due. Instructor: Sam Palermo

1. Use Mason's rule to derive the transfer function, G(s)=Y(s)/U(s), of the system below. Clearly state the forward path gains, loop gains, system determinant, and forward path determinants.



2. Let's consider a second-order type-2 charge-pump PLL: $K_{PD}=100\mu A/(2\pi)$ radian $K_{VCO}=2\pi^{*}(1 \text{ GHz})/V$

- N=32
- Find the specs for the loop filter such that $\omega_n = 2\pi \times 10$ MHz for $\zeta = 1, 0.2, 5$
- Implement a linear macromodel (MATLAB, etc.) for the closed-loop system.
 - Plot the open-loop gain magnitude and phase and find the phase margin. For both the magnitude and phase plots, overlay all the curves for the different ζ values on one clearly labeled plot.
 - Give the closed-loop pole values for $\zeta = 1, 0.2, 5$.
 - o Plot the output phase transfer function (both magnitude and phase) and error transfer function (magnitude and phase) from 0.1 ω_n to 10 ω_n . For both the magnitude and phase plots, overlay all the curves for the different ζ values on one clearly labeled plot.
 - Plot the output phase and phase error transient response to a unit phase step. For both of these plots, overlay all the curves for the different ζ values on one clearly labeled plot.
 - Using the information obtained from the frequency-domain and transient phase step plots, comment on the system behavior as ζ changes.

- 3. Now let's consider the more realistic case where we have an additional filtering capacitor C_2 in parallel to the main loop filter. Set $C_2=0.1*C_1$ and, without modifying the R and C_1 values from #1, repeat the previous plots.
 - Plot the open-loop gain magnitude and phase and find the phase margin. For both the magnitude and phase plots, overlay all the curves for the different ideal 2^{nd} order ζ values on one clearly labeled plot.
 - Give the closed-loop pole values for ideal 2^{nd} order $\zeta = 1, 0.2, 5$.
 - \circ Plot the output phase transfer function (both magnitude and phase) and error transfer function (magnitude and phase) from 0.1 ω_n to 10 ω_n. For both the magnitude and phase plots, overlay all the curves for the different ideal 2nd order ζ values on one clearly labeled plot.
 - Plot the output phase and phase error transient response to a unit phase step. For both of these plots, overlay all the curves for the different ideal 2^{nd} order ζ values on one clearly labeled plot.
 - Using the information obtained from the frequency-domain and transient phase step plots, comment on the system behavior as the ideal 2^{nd} order ζ changes. How is this more realistic 3^{rd} order system different from the ideal 2^{nd} order system of #1?