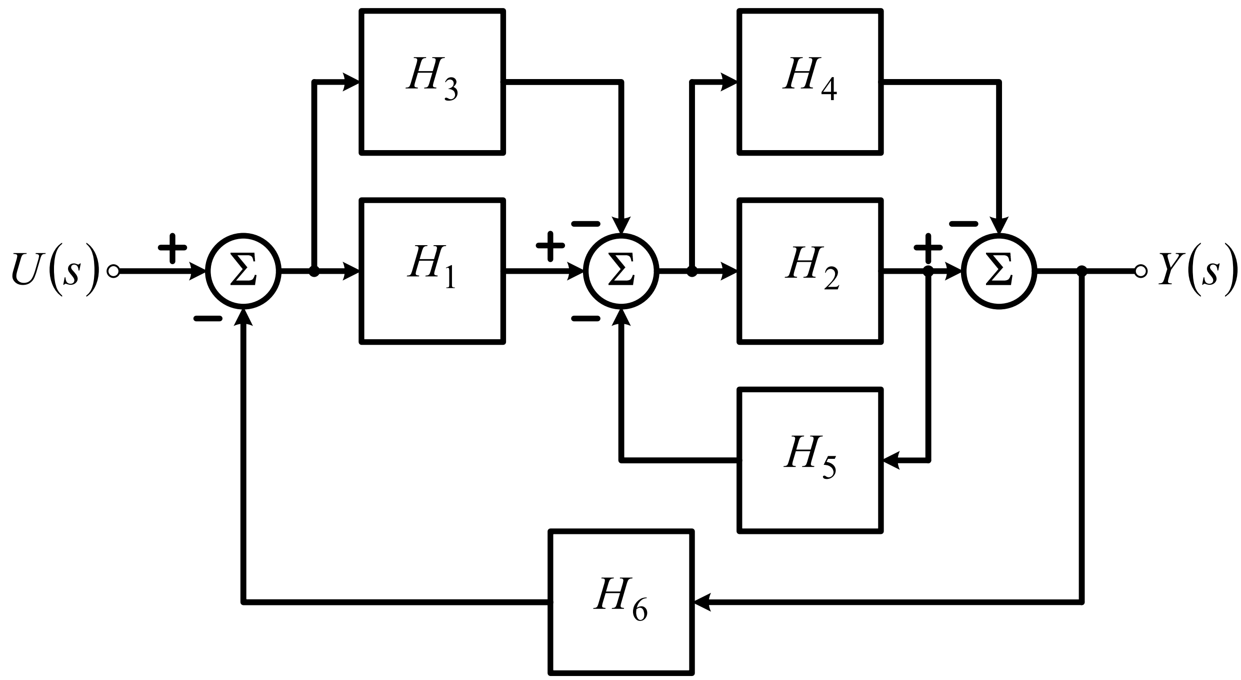
September 3, 2025

ECEN 620

Homework #1

Due: 9-16-2025, 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}=100µA/(2π) radian
K_{VCO}=2π*(1 GHz)/V
N=32

- Find the specs for the loop filter such that ω_n=2π*10 MHz for ζ = 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 ζ = 1, 0.2, 5.
  - 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 2nd order ζ values on one clearly labeled plot.
   - Give the closed-loop pole values for ideal 2nd order $\zeta = 1, 0.2, 5$.
   - Plot the output phase transfer function (both magnitude and phase) and error transfer function (magnitude and phase) from $0.1\ \omega_n$ to $10\ \omega_n$. 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 2nd 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 2nd order ζ changes. How is this more realistic 3rd order system different from the ideal 2nd order system of #1?