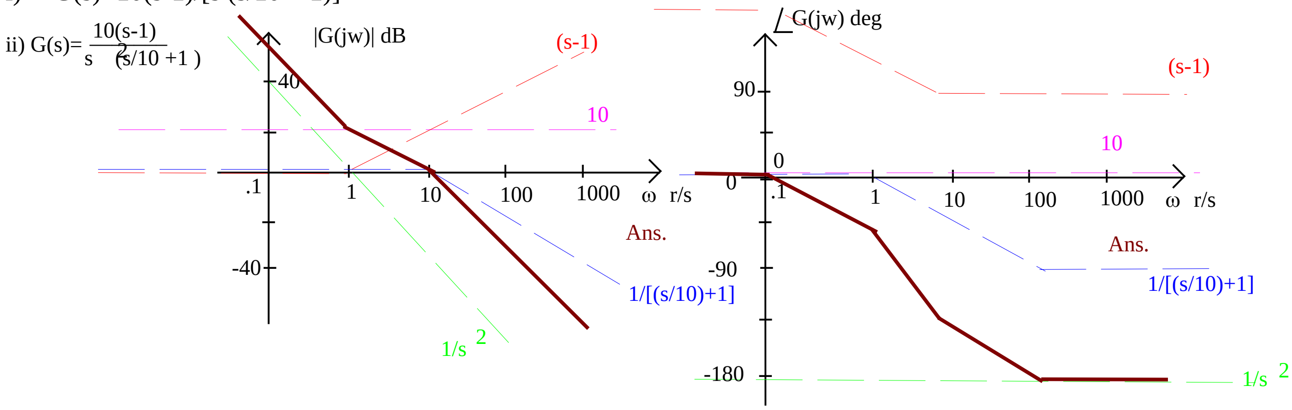
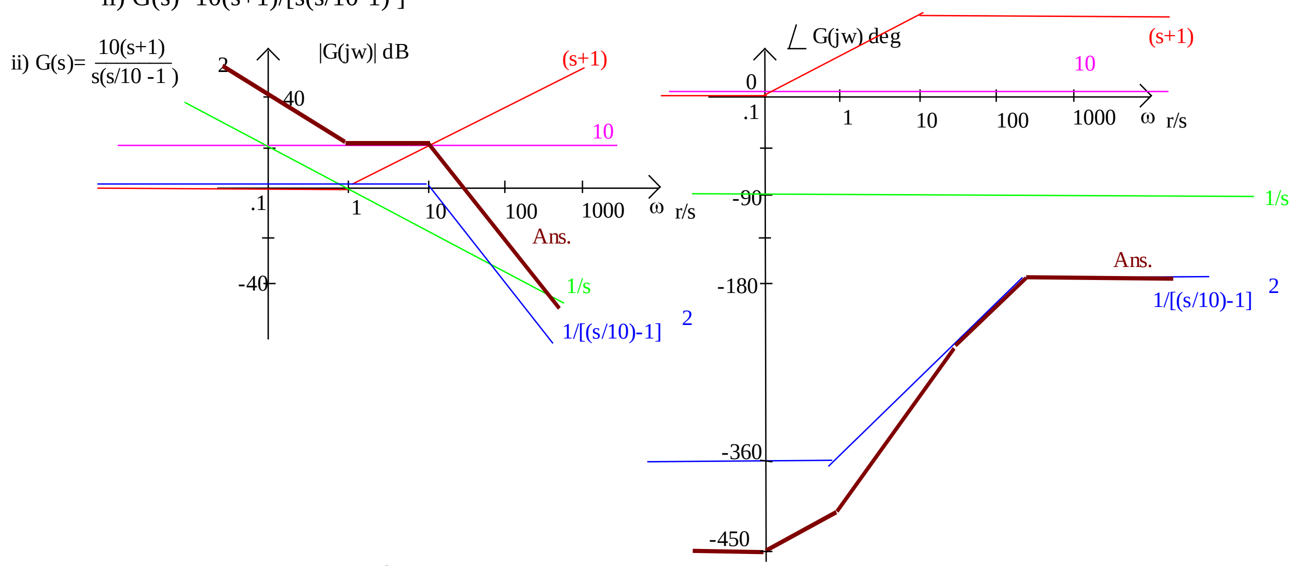
EE571 Solution to HW#26

b) Use semi-log paper to construct the Bode Plots (both magnitude and phase) for the following transfer functions:

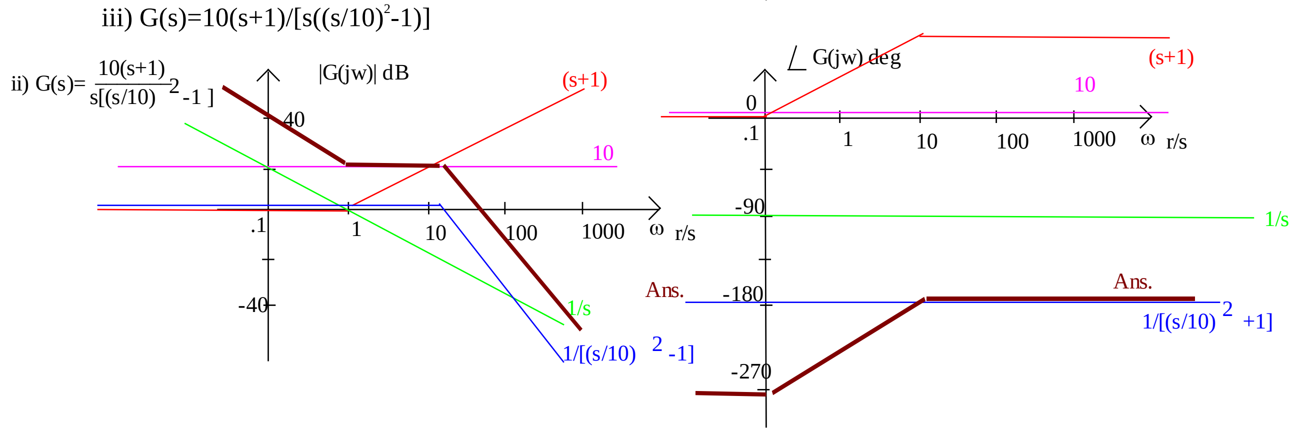
i) $G(s)=10(s-1)/[s^2(s/10 + 1)]$



ii) $G(s)=10(s+1)/[s(s/10-1)^2]$



iii) $G(s)=10(s+1)/[s((s/10)^2-1)]$



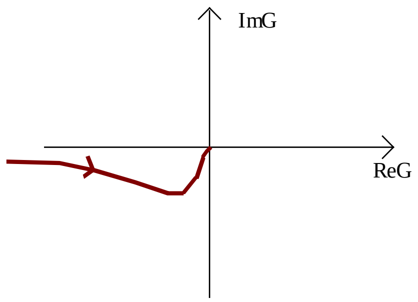
b) The magnitude plot is the same as the plot in HW#25. Thus, our **minimum phase** solution is: $G(s)=100(s/10 +1)/[s^1(s/1+1)(s/100+1)]$. However, the corresponding phase response of this G(s) should level off at -180 degrees at high frequencies. Our phase plot continues to decrease at high frequencies thereby implying that transportation lag is present! Thus, our revised guess at G(s) is $G(s)= 100(s/10 +1)e^{-sT} /[s^1(s/1+1)(s/100+1)]$. To find T, we note that from the Bode plot, the slope at high frequencies (i.e., frequencies well above the last break point at 100) is -225-(-180) deg/(10,000-1,000 rad/sec) = -0.005 deg/rad/sec. Note that the slope of the theoretical transfer function G(s) at frequencies well above the highest breakpoint is (-T)(180 deg)/(3.14159 rad/sec). Equating the two expressions, we obtain T=8.727 x 10^{-}

[5] and, therefore, $G(s)= 100(s/10 +1)e^{-0.00008727s} /[s^1(s/1+1)(s/100+1)]$. (Note: we will see that for such a system with such small transportation delay, we can effectively ignore this delay when considering stability)

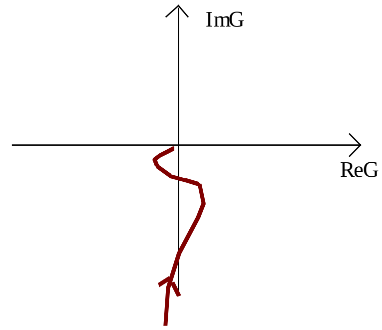
2. a) Use your answers from HW#25 to sketch the ploar plots of:

i) $G(s)=10(s+1)/[s^2(s/10 + 1)]$ ii) $G(s)=10(s+1)/[s(s/10+1)^2]$ iii) $G(s)=10(s+1)/[s((s/10)^2+1)]$

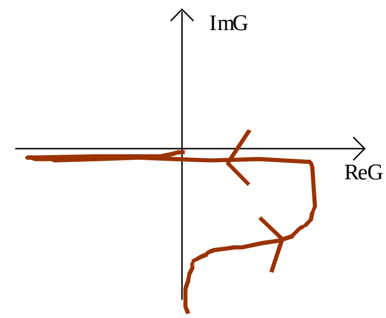
i)



ii)

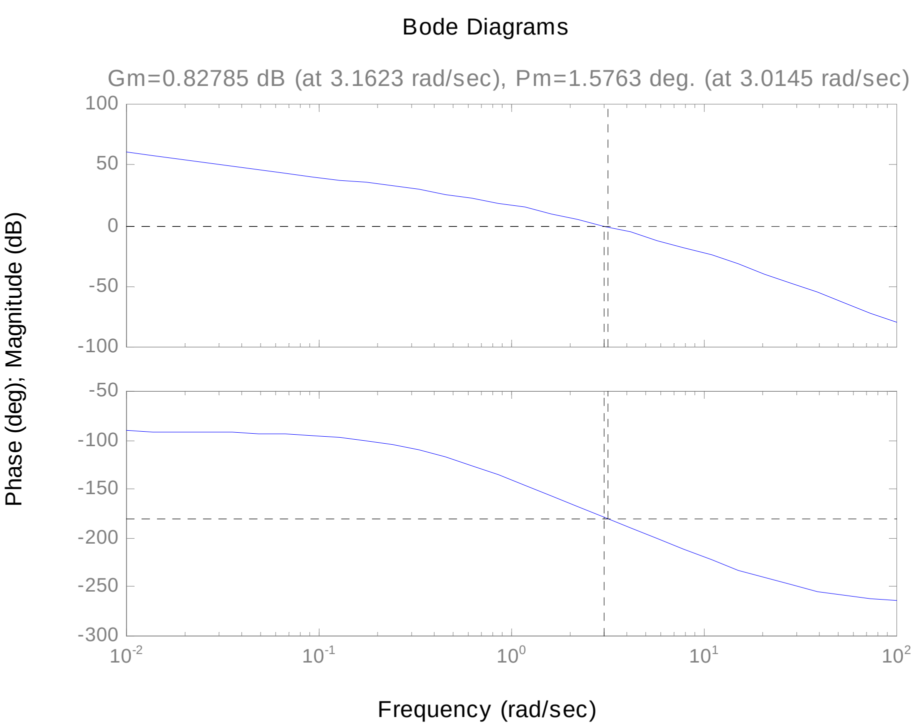


iii)



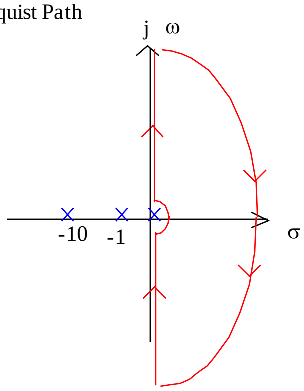
b) For the open-loop transfer function, $G(s)=10/[s(s+1)(s/10 + 1)]$, draw the appropriate Nyquist Path then make a Nyquist plot.

First, draw the Bode plot:

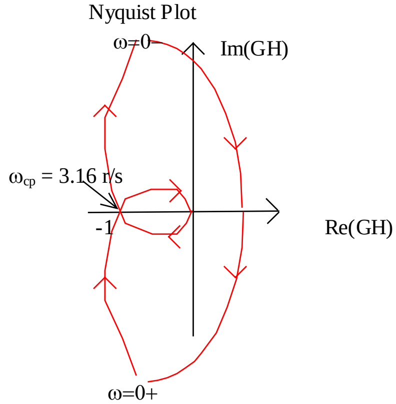


Note that the magnitude of the Bode plot when the phase = -180 degrees is -0.82785 dB which is slightly less than 0 dB. Therefore, the polar plot will cross the negative real axis just slightly to the right of the point –1+j0 and won't encircle it (see below)

Nyquist Path



Nyquist Plot



c) Use your Nyquist plot to determine what would happen if we formed a closed-loop system out of G(s), would the closed-loop system be stable (i.e., does the Nyquist plot encircle the point –1+j0)? Hint: You may want to have Matlab make a Bode plot of G(s) then look at the magnitude of G(jω) when the phase plot crosses –180 degrees. If this magnitude is greater than 0 dB (i.e., greater than 1), then the Nyquist plot will encircle the point –1+j0.

The closed-loop system will have 0 closed-loop poles in the RHP because the Nyquist Plot does NOT encircle the –1+j0 point.