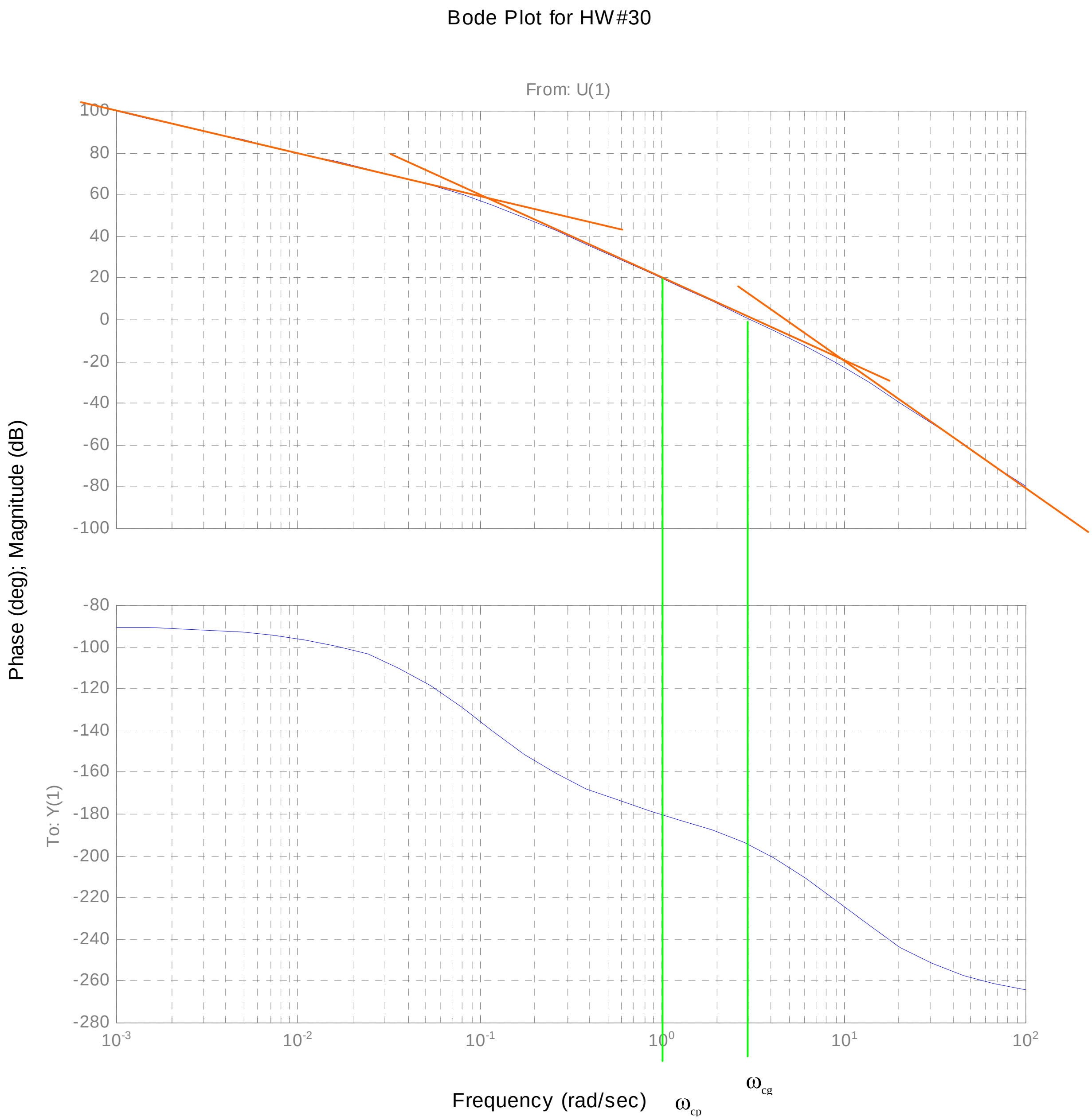
1. a) From the Bode Plot below, find Y(s)/W(s)=G(s), the open-loop transfer function (assume H(s)=1)



Soltion: G(s) =100/(10s+1)(0.1s+1)

b) For the system in part b), find the type #, Kp, Kv, $ess|_{step}$ and $ess|_{ramp}$

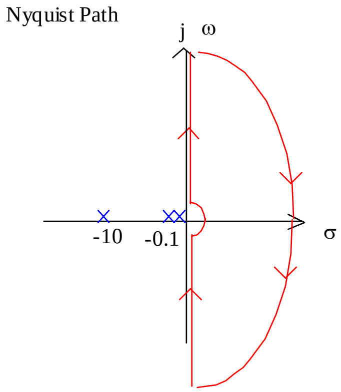
Solution: Type # is one, Kp is infinite, Kv =100, $ess|_{step} = 0$ $ess|_{ramp} = 0.01$

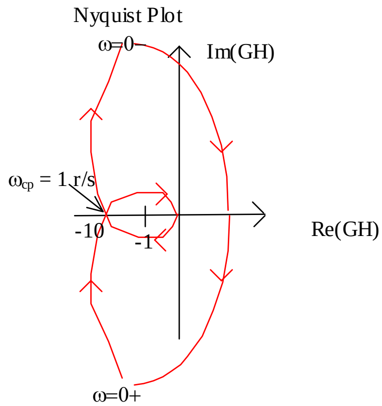
c) Find the gain cross-over frequency (ω_{cg}), the phase cross-over frequency (ω_{cp}), the gain margin (gm) and the phase margin (pm).

Soltution: From the Bode Plot, ω_{cg} = 3.1 rad/sec , ω_{cp} = 1.0 rad/sec and gm = -20 dB and pm = -16 degrees

d) Draw the Nyquist path and the Nyquist Plot. How many closed-loop poles are in the RHP?

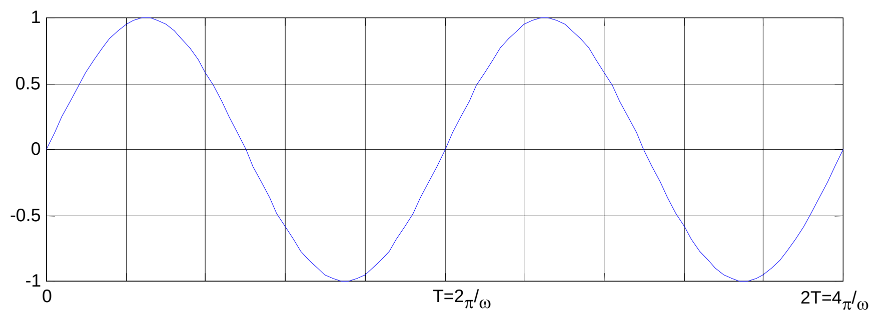
Solution





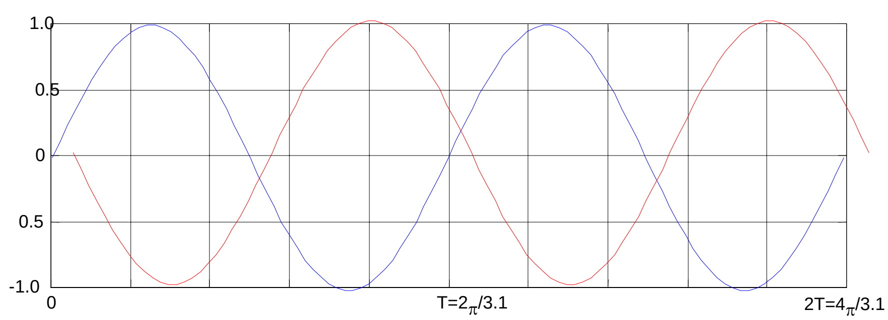
N=Z-P = 2. Therefore, there are 2 RHP closed-loop poles.

e) Consider the signal w(t)=1sinωt shown below:

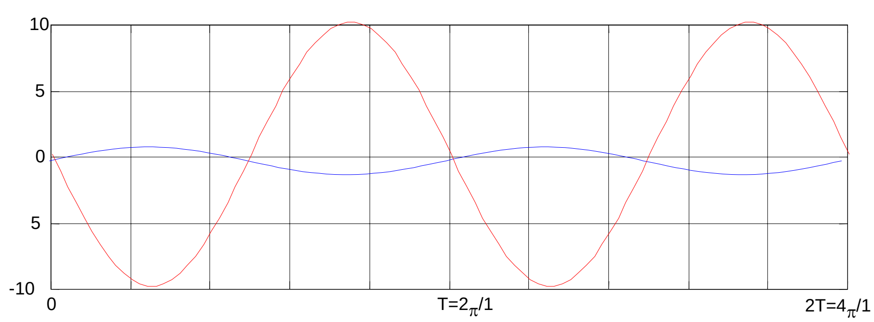


Suppose we input this signal to our OPEN-LOOP system G(s)=Y(s)/W(s). Use the bode plot to sketch the **steady state** output $y_{ss}(t)$ and w(t) versus time when: i) $\omega = \omega_{cg}$ ii)) $\omega = \omega_{cp}$

Solution: At $\omega = \omega_{cg}$ = 3.1 rad/sec, the two plots have the same magnitude but the output lags the input by –196 degrees (pm = -16 deg.).



At $\omega = \omega_{cp}$ = 1.0 rad/sec, the two plots are 180 degrees out of phase but the output is 10 times greater than the input (gm = -20 db).



f) Design the simplest compensator such that the compensated system satisfies the following specifications:

i) gm = 20 dB

ii) pm > 10^o

Solution: Gc= Kc = $gm_{current} - gm_{desired}$ = -20 db - 20 db = -40 db = 0.01

g) If we use this compensator, what have you done to the steady-state error due to a ramp?

Soltion: We have increased the steady-state error by a factor of 100 times!