CM 3310
Third Exam
April 17, 2001 7-9pm

Name: _____ Box No. _____

1. (10 pts) With the feedback system given by Figure 1, suppose the process transfer function $G_p(s)$ yields a Nyquist plot given in Figure 2. Using a proportional controller, what maximum range of positive controller gains will the process become unstable ?

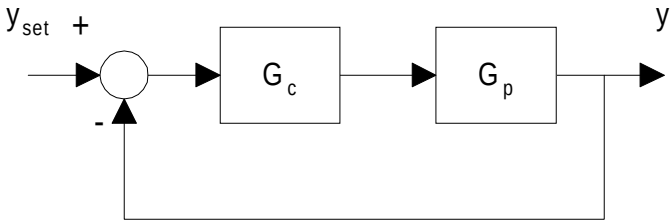


Figure 1.

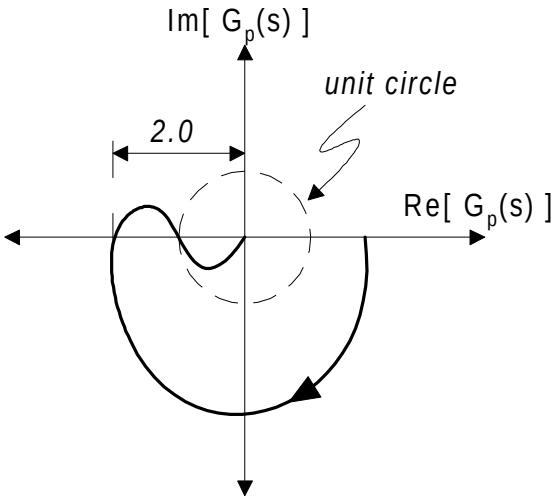


Figure 2.

2. For the feedback control process shown in Figure 1, $G_p(s)$ is the open-loop transfer function while $G_c(s)$ is the controller transfer function. The Bode plots for Gp is shown in Figure 3.

   a) (10 pts) Determine if using a proportional controller, with $G_c(s)=0.4$, will yield a stable closed-loop system.
   b) (20 pts) Using the plots shown in Figure 3, what values will be obtained for a PID controller using Ziegler-Nichols controller tuning rules ?

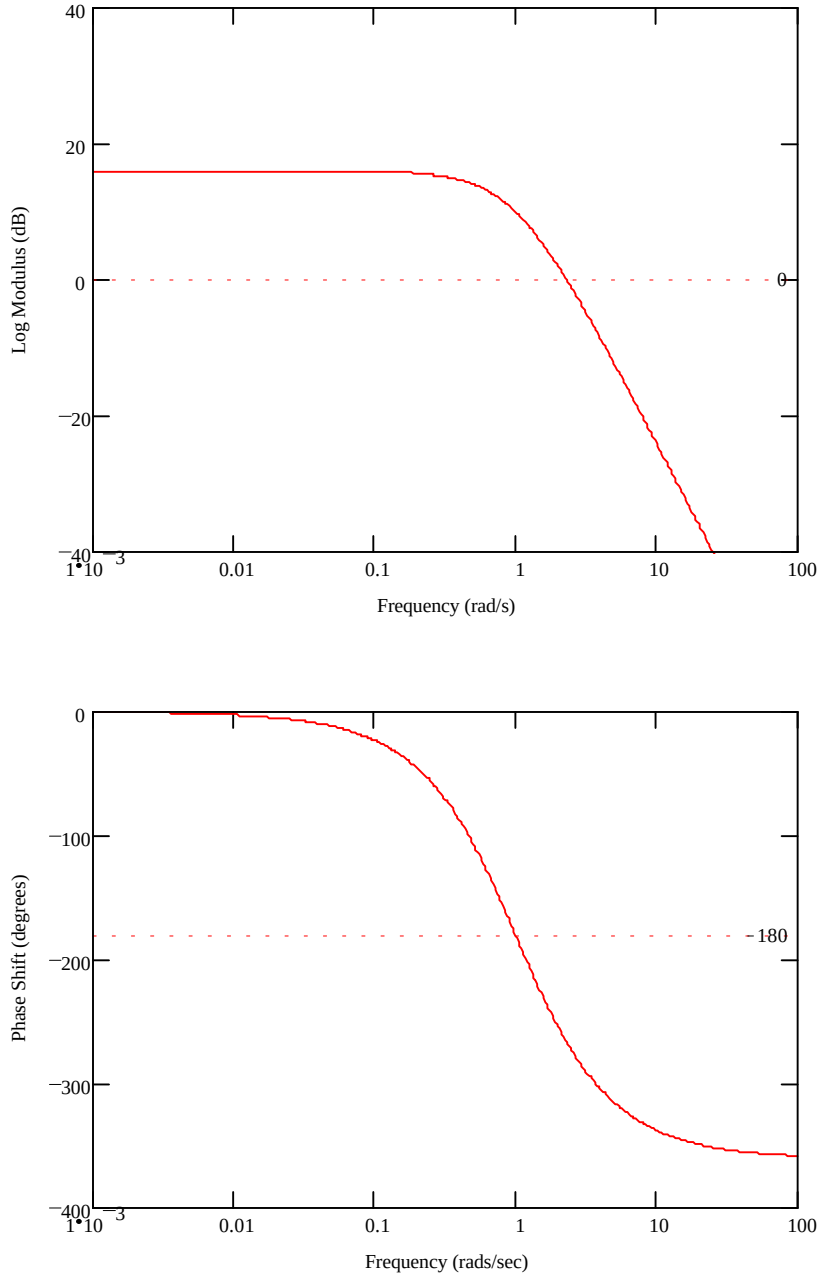


Figure 3.

3. (20 pts) From the block diagram shown in Figure 4, calculate the magnitude ratio as a function of frequency, MR(ω), from input u to output y.

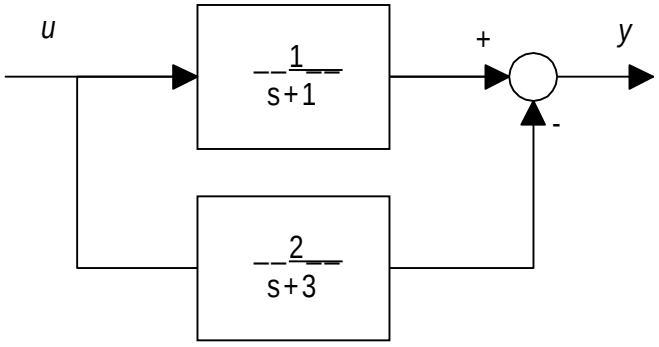


Figure 4.

4. (20 pts) From the Bode plots of $G_cG_p(s)$ shown in Figure 5, calculate the gain margin and phase margin of the feedback system.

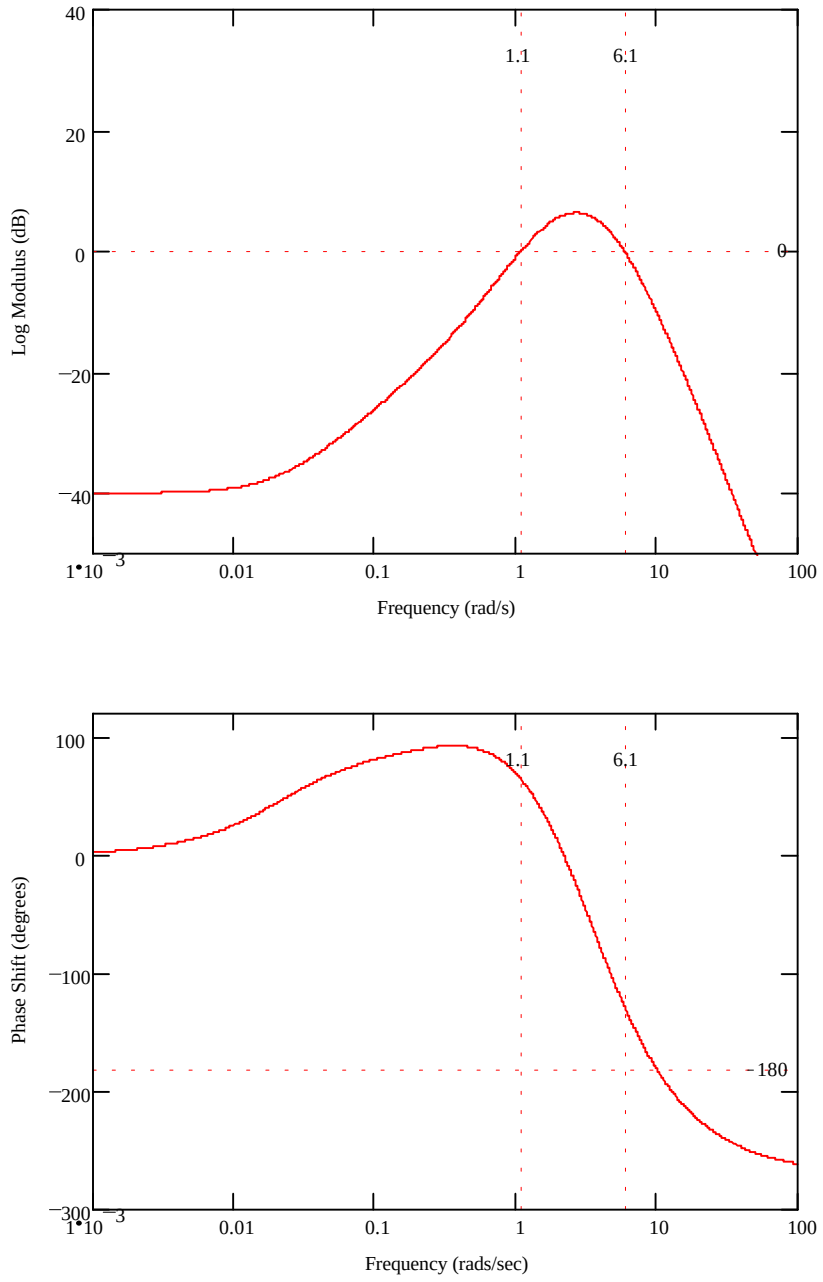


Figure 5.

5. (20 pts) For the given cases in Table 1, determine which transfer functions from Table 2 matches each case.

Table 1

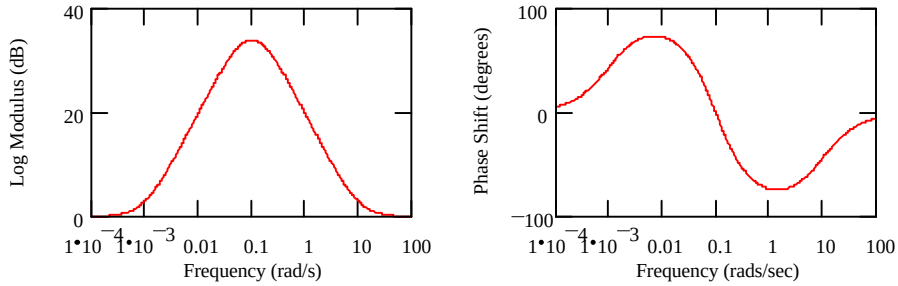
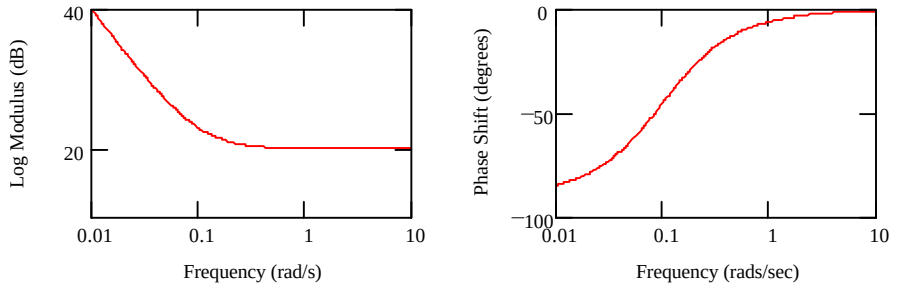
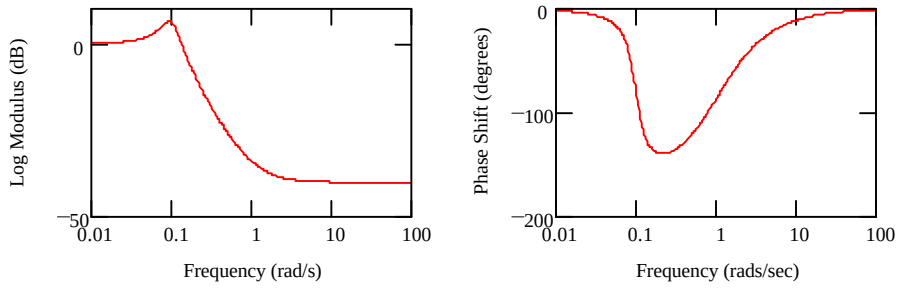
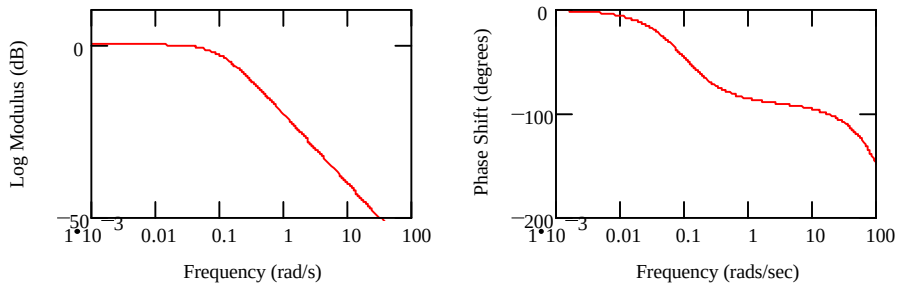
Case 1	
Case 2	
Case 3	
Case 4	

Table 2.			
G1:	$\frac{(s+1)^2}{100 \cdot s^2 + 5 \cdot s + 1}$	G5:	$\frac{\exp((-0.01 \cdot s))}{10 \cdot s + 1}$
G2:	$1 - \frac{1}{10 \cdot s + 1}$	G6:	$\frac{(s+1)^2}{s^2 + s + 1}$
G3:	$\frac{(10 \cdot s + 1)^2}{(1000 s + 1) \cdot (0.1 \cdot s + 1)}$	G7:	$\frac{(1000 s + 1) \cdot (0.1 \cdot s + 1)}{(10 \cdot s + 1)^2}$
G4:	$10 \cdot \left(1 + \frac{1}{10 \cdot s}\right)$	G8:	$\frac{\exp(-0.01 \cdot s)}{s + 10}$

6. (Bonus: 10 pts) A frequency response experiment at a particular frequency is shown in Figure 6. What is the corresponding log modulus (in decibels) and phase shift (in degrees) ?

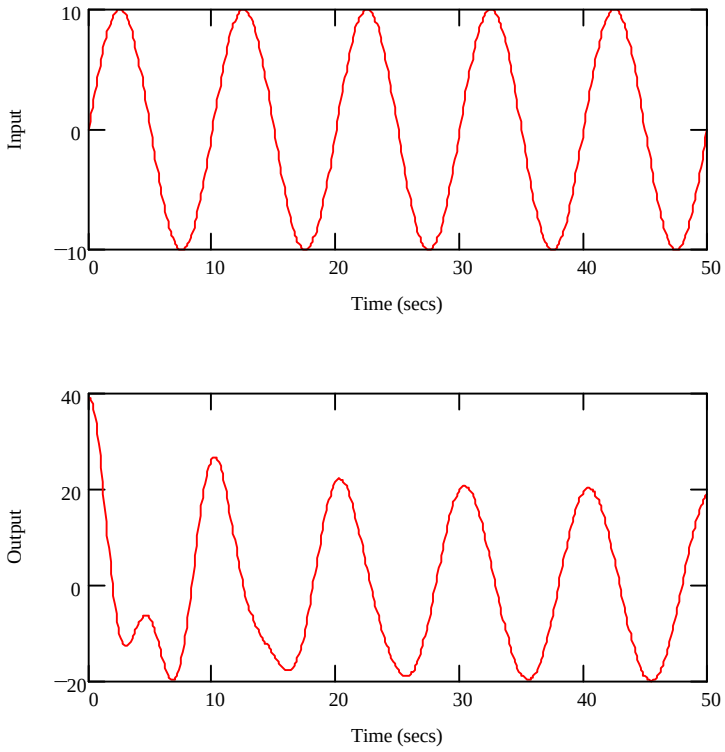


Figure 6.