CM 3310
Third Exam
April 30, 2002
7:30 – 9:30 pm

Name: _____ Box No. _____

1. For the process obtained as the equivalent transfer function from *u* to *y* given in Figure 1,
   a) (20 pts) Obtain the magnitude ratio as a function of frequency ω (rads/sec)
   b) (Bonus: 10 pts) Obtain a rough sketch of the Bode plot of log modulus (in dB) vs. frequency (in log scale) by indicating the behavior in frequency ranges which includes $1/\tau_1$, $1/\tau_2$ and $1/(\tau_1+\tau_2)$, with $\tau_2 >> \tau_1$.

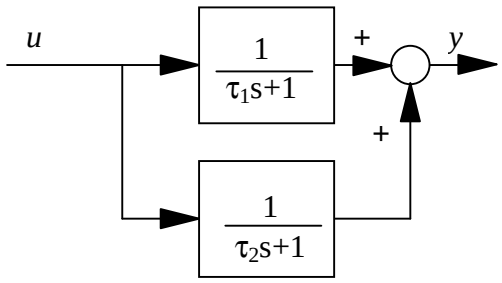


Figure 1.

2. (25 pts) The Bode plot for $G_p(s)$ is given in Figure 2. Determine the Ziegler-Nichols tuning for a PID controller, $G_c(s)$, for the feedback control scheme shown in Figure 3.

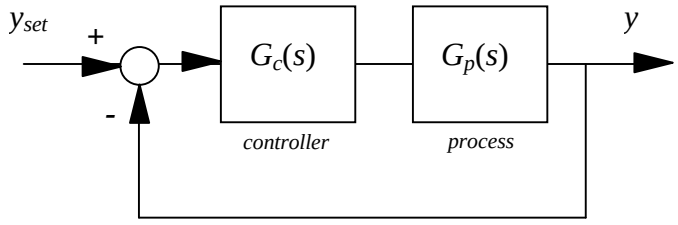


Figure 3.

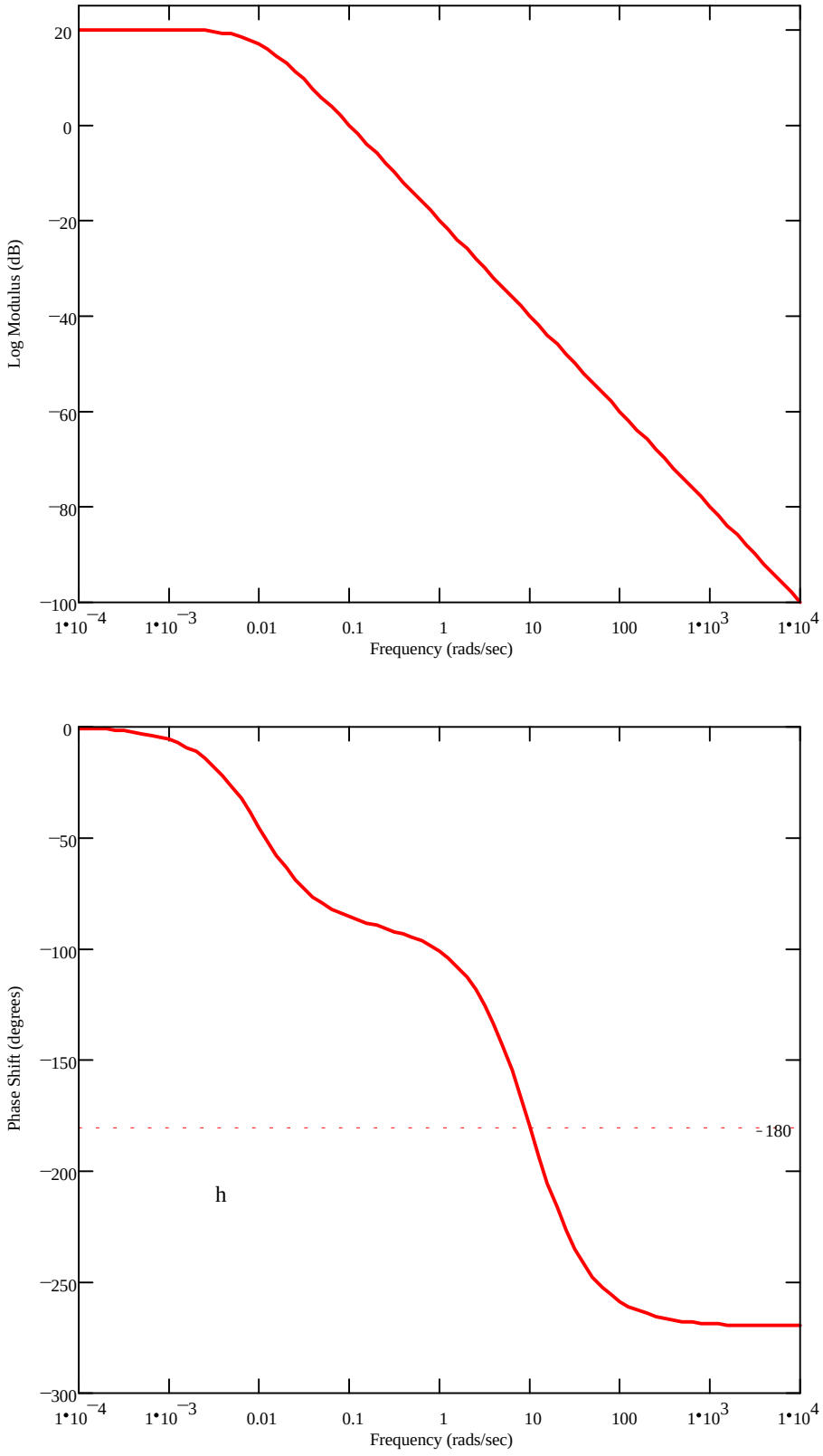
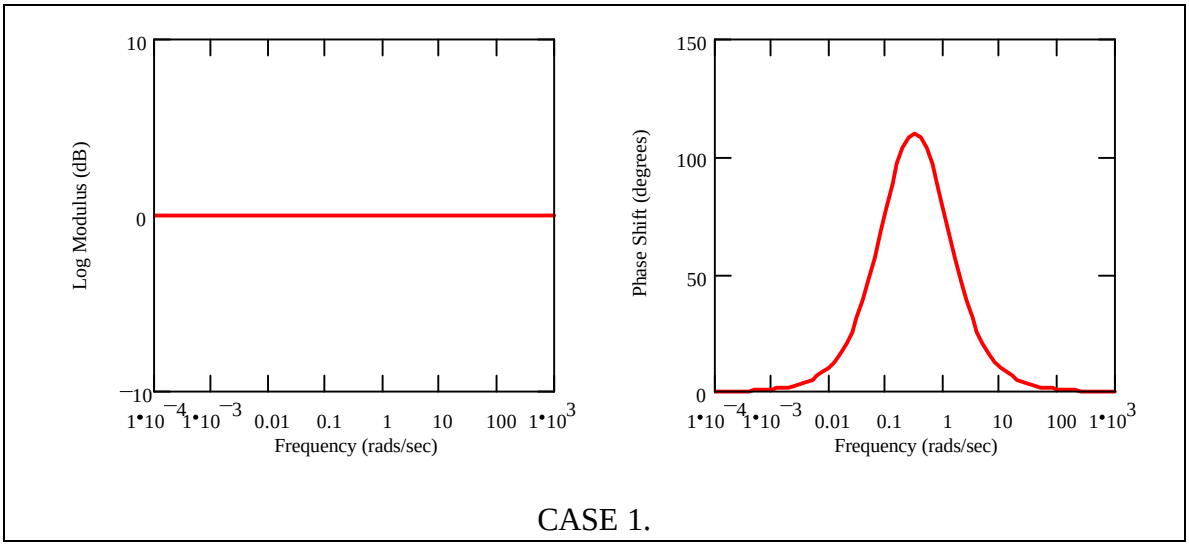
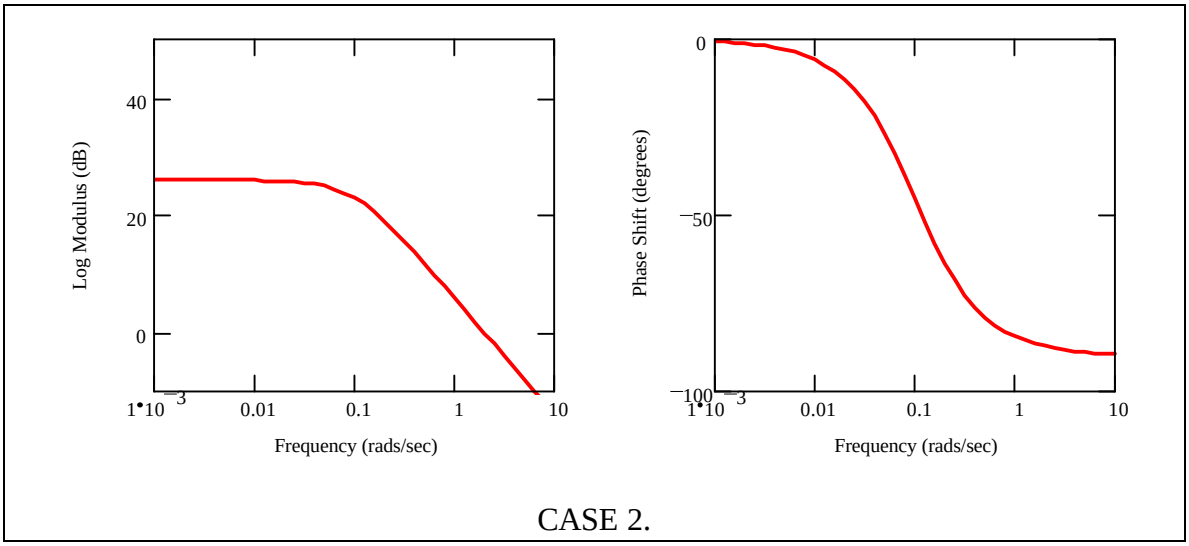

20
0
−20
−40
−60
−80
−100
Log Modulus (dB)
1•10−4
1•10−3
0.01
0.1
1
10
100
1•103
1•104
Frequency (rads/sec)
0
−50
−100
−150
−180
−200
−250
−300
Phase Shift (degrees)
h
1•10−4
1•10−3
0.01
0.1
1
10
100
1•103
1•104
Frequency (rads/sec)

Figure 2.

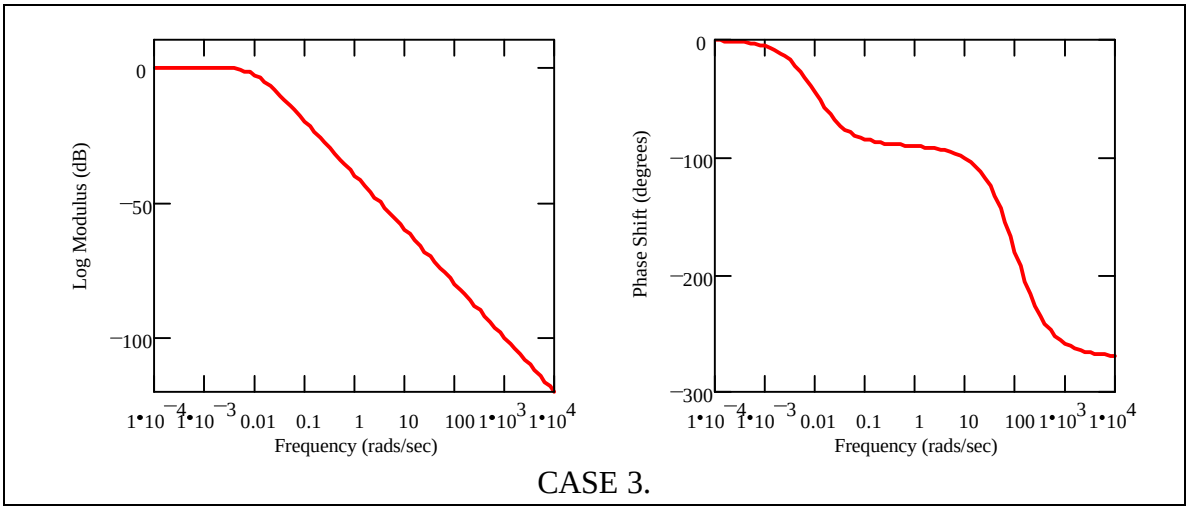
3. (20 pts) Obtain the transfer functions given in Table 1 that matches the Bode plots given as cases 1 to 4 that are shown in Figure 4.



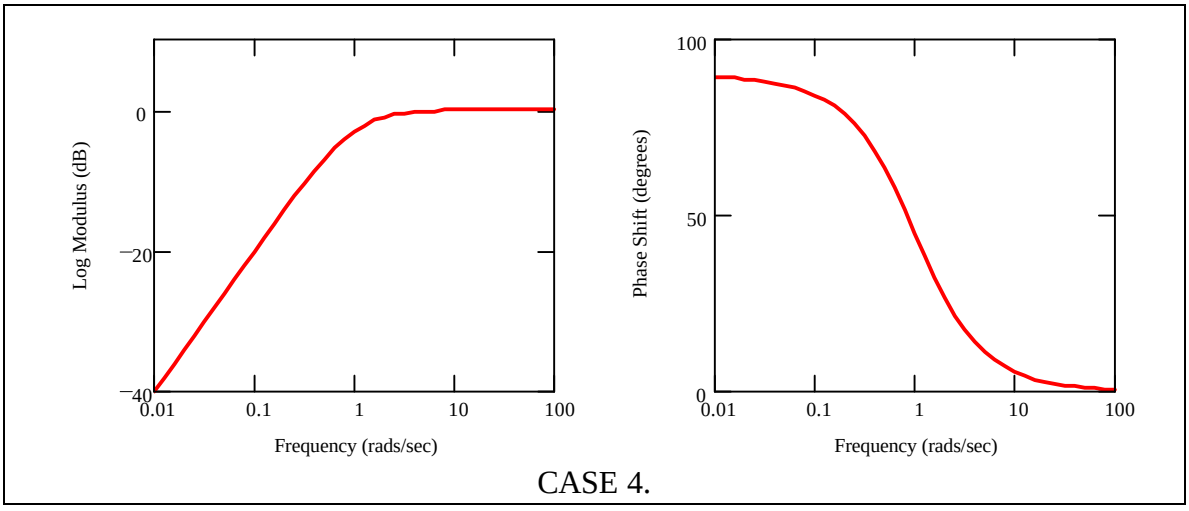
CASE 1.



CASE 2.



CASE 3.



CASE 4.

Table 1.

$G_1(s)$	$\frac{(-0.01 \cdot s + 1)}{(100 \cdot s + 1) \cdot (0.01 \cdot s + 1)}$
$G_2(s)$	$\frac{(10 \cdot s + 1) \cdot (s - 1)}{(s + 1) \cdot (10 \cdot s - 1)}$
$G_3(s)$	$1 - \frac{1}{s + 1}$
$G_4(s)$	$1 + \frac{1}{s}$
$G_5(s)$	$\frac{1}{0.5 \cdot s + 0.05}$

4. Consider the Nyquist plot for a process, $Gp(s)$, given in Figure 4.
   a) (10 pts) Using a proportional controller, $Gc(s)=0.5$ in a feedback control scheme as shown in Figure 3, what is the resulting gain margin?
   b) (15 pts) Using a proportional controller in a feedback control scheme as shown in Figure 3, what should be the proportional control gain be so that the resulting phase margin is 45^o ?

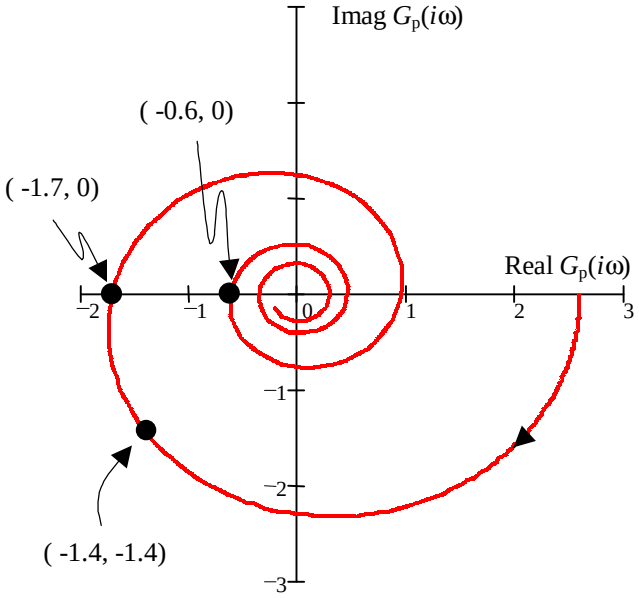


Figure 4

5. (10 pts) From the frequency response plots of the input and output signals, obtain the log modulus (in decibels) and phase shift (in degrees).