CM 3310
Third Exam
April 24, 2003
Open Book/Open Notes

Name: ____Box No. __________

1. (15 pts) For one trial in a frequency response experiment where an input sinusoid with an amplitude, A, of 10 and period, P, of 10 sec, the engineer recorded the log modulus to be 7 dB and the phase shift to be -200^o. From this information, determine the amplitude, B, and time shift, t_{shift}, of the output sinusoid for this particular trial.

2. For the feedback process given in Figure 1,

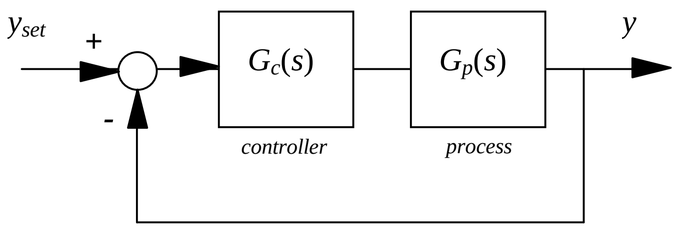


Figure 1.

the Nyquist plot of G_p is given in Figure 2.

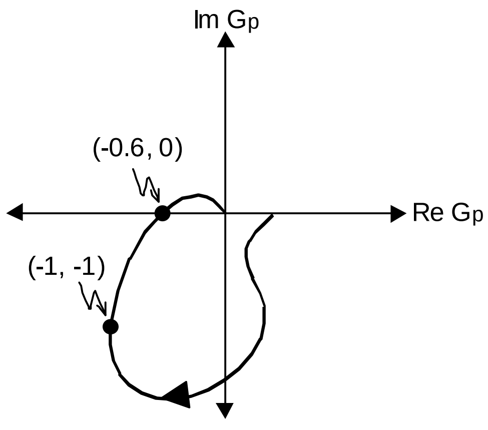
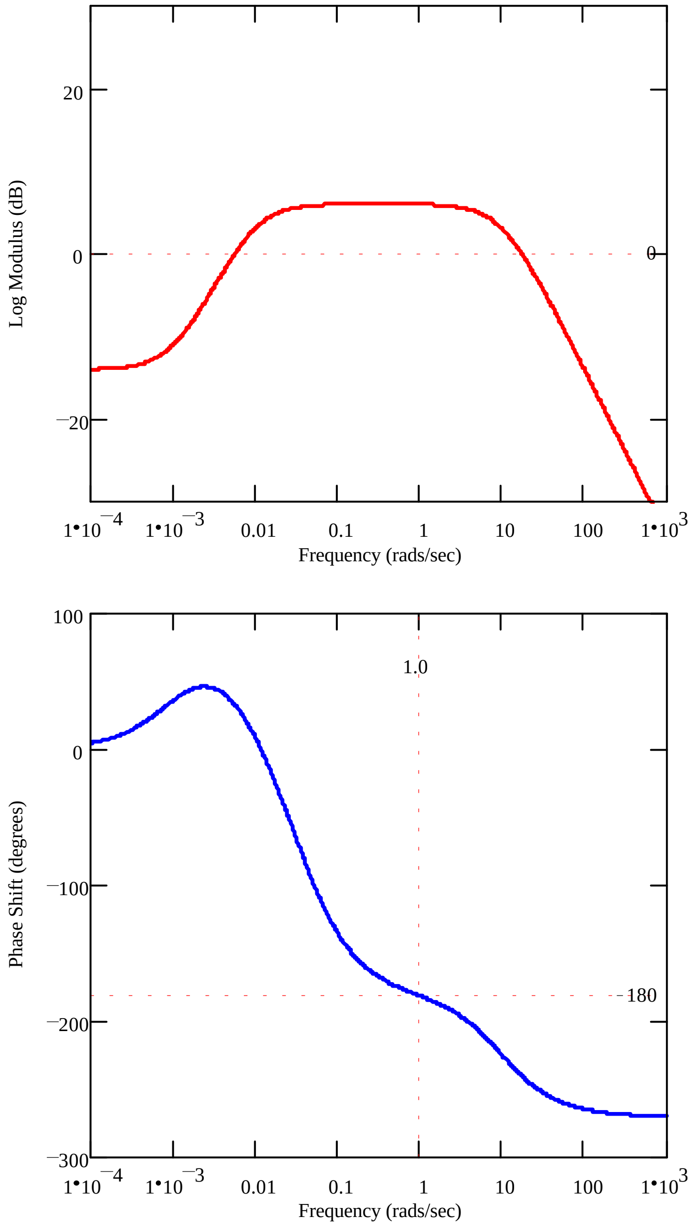


Figure 2.

a) (10 pts) Using a proportional control, $G_c=K_c$, what should the value of proportional gain be in order to achieve a gain margin of 3.0.

b) (10 pts) Using a proportional control, $G_c=K_c$, what should the value of proportional gain be in order to achieve a phase margin of 45^o.

3. (20 pts) Suppose, with the same feedback configuration given in Figure 1, the process, G_p, is replaced by another one whose Bode plots are given in Figure 3. Determine a set of PID tuning parameters, i.e. K_c, τ_I and τ_D, based on the Ziegler-Nichols method.



4. (20 pts) Determine which transfer functions given in Table 1 will match each of the Bode plots given as cases 1 to 4, shown in Figure 4.

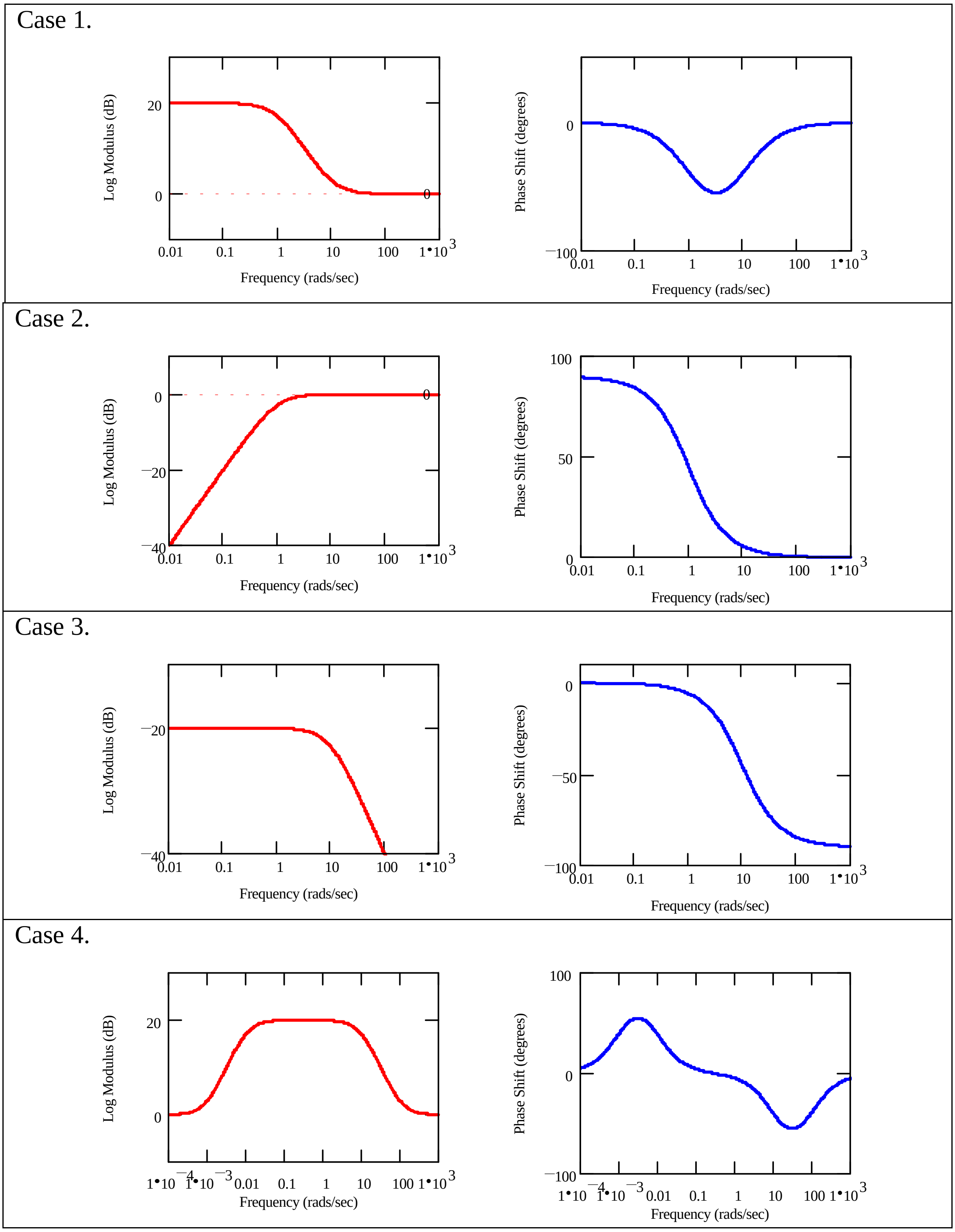


Figure 4.

Table 1.

$G_1(s) = \dfrac{1}{10s+1}$	$G_5(s) = \dfrac{\exp(-10s)}{10s+1}$
$G_2(s) = \dfrac{1}{s+10}$	$G_6(s) = \dfrac{1}{-s+10}$
$G_3(s) = 1 - \dfrac{1}{s+1}$	$G_7(s) = \dfrac{(s+0.01)(s+10)}{(s+0.0001)(s+100)}$
$G_4(s) = \dfrac{(s+0.001)(s+100)}{(s+0.01)(s+10)}$	$G_8(s) = 1 + \dfrac{9}{s+1}$

5. (25 pts) For the process obtained as the equivalent transfer function from u to y given in Figure 5, obtain the magnitude ratio as a function of frequency ω (rads/sec).

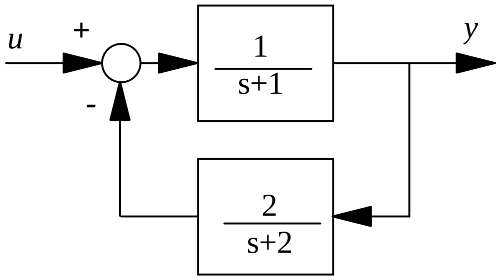


Figure 5.

6. (Bonus:10 pts) Given the path, Γ, which is the semicircle with radius R=2, shown in Figure 6,

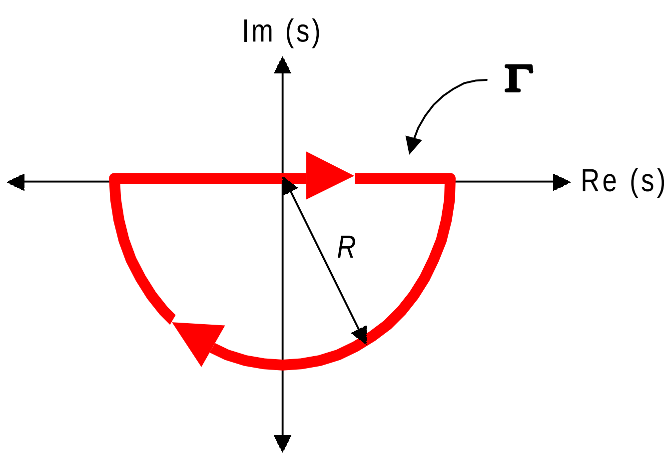


Figure 6.

determine how many times the complex map of G(s), given by

$$G(s) = \frac{1}{(s+1)^2 + 1}$$

will encircle the origin in the clockwise manner, as s traverses the path Γ in the clockwise manner.