CM3310
Third Exam
Open Book/Open Notes
April 15,2004 7-9pm

Name_____ **Box No** _____

1. (30 pts) For the feedback system shown in Figure 1, with the transfer functions given by

$$G_p = \frac{5}{(2s+1)}$$

$$G_c = 2\frac{s+1}{s}$$

obtain the magnitude ratio of G_{cl}, the closed loop transfer function from y_{set} to y, as a function of frequency, ω (rads/sec).

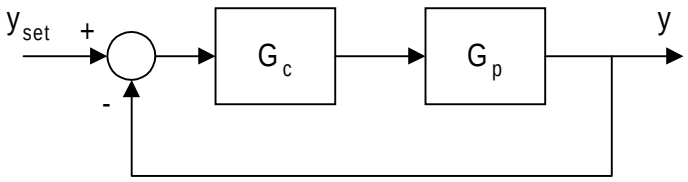

Figure 1.

(**Hint/Check**: Magnitude ratio of G_{cl} at ω=1 rad/sec is 1.04)

2. (10 pts) Consider the same feedback structure shown in Figure 1, but with a different process transfer function, Gp, whose nyquist plot is shown in Figure 2. Using a proportional control, G_c=K_c, determine the value of K_c so that the resulting gain margin of G_cG_p is 1.75.

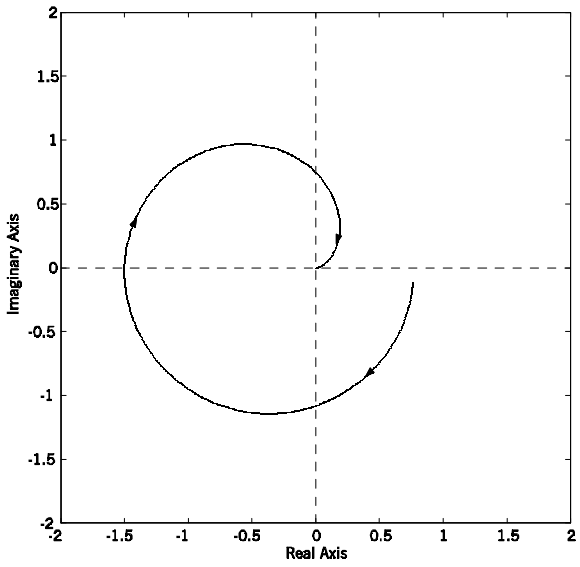

Figure 2. Nyquist plot of G_p .

3. (30 pts) Consider again the feedback system shown in Figure 1, but this time the Bode plot of G_p is given in Figure 3. Obtain the PI control tuning based on the Tyreus-Luyben rules.

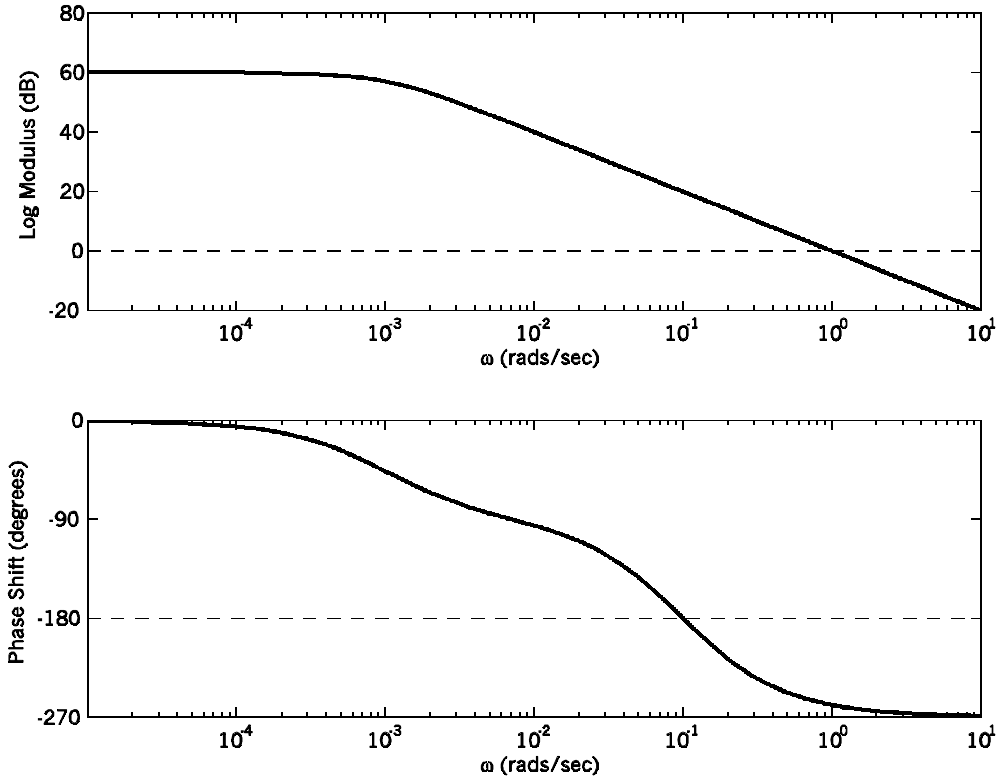

Figure 3.

4. (30 pts) Determine which of the transfer functions given in Table 1 matches the Bode plots shown in Figures 4, 5 and 6.

Table 1.

G1=	$\frac{(10s+1)(s+0.01)}{s(s+1000)}$		G5=	$\frac{s+0.01}{s+100}$
G2=	$\frac{10}{100s^2+2s+1}$		G6=	$\frac{1}{100s^2+2s+1}$
G3=	$\frac{s+100}{s+0.01}$		G7=	$\frac{10(s+10)(s+0.01)}{s(s+1000)}$
G4=	$1+\frac{-s+1}{0.01s+1}$		G8=	$\frac{e^{-2s}}{s+100}$

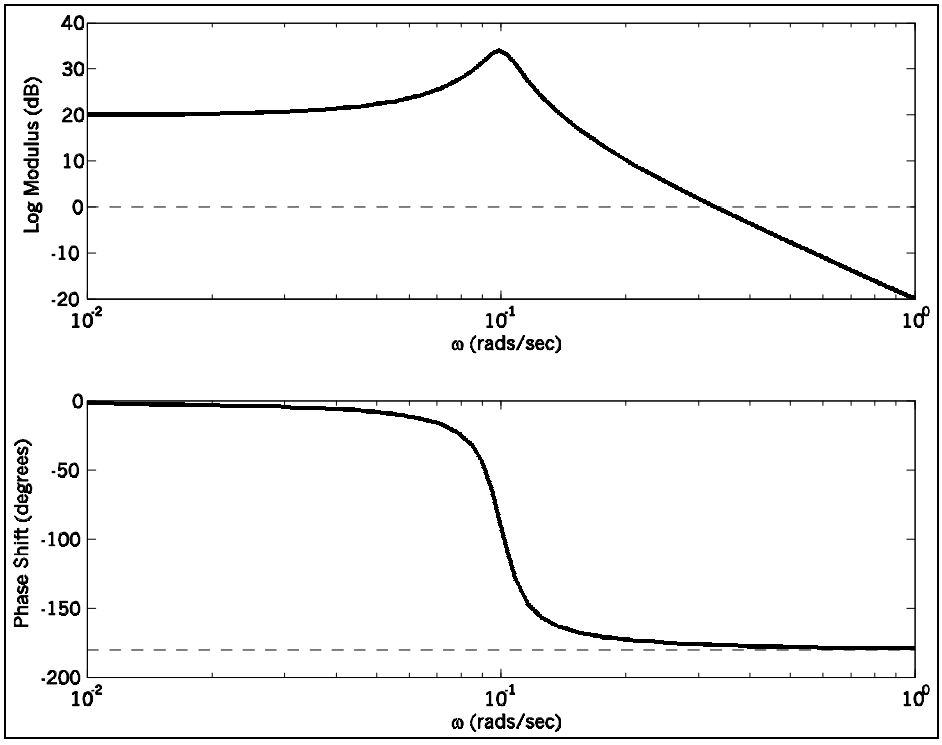

Figure 4. Bode plot for Case 1.

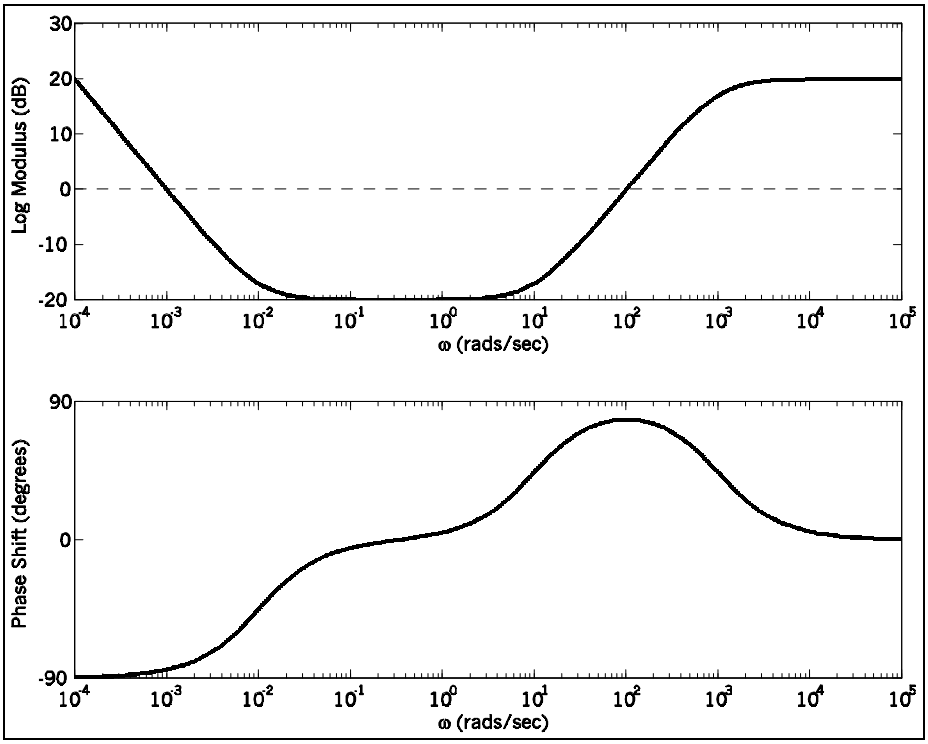

Figure 5. Bode plot for Case 2.

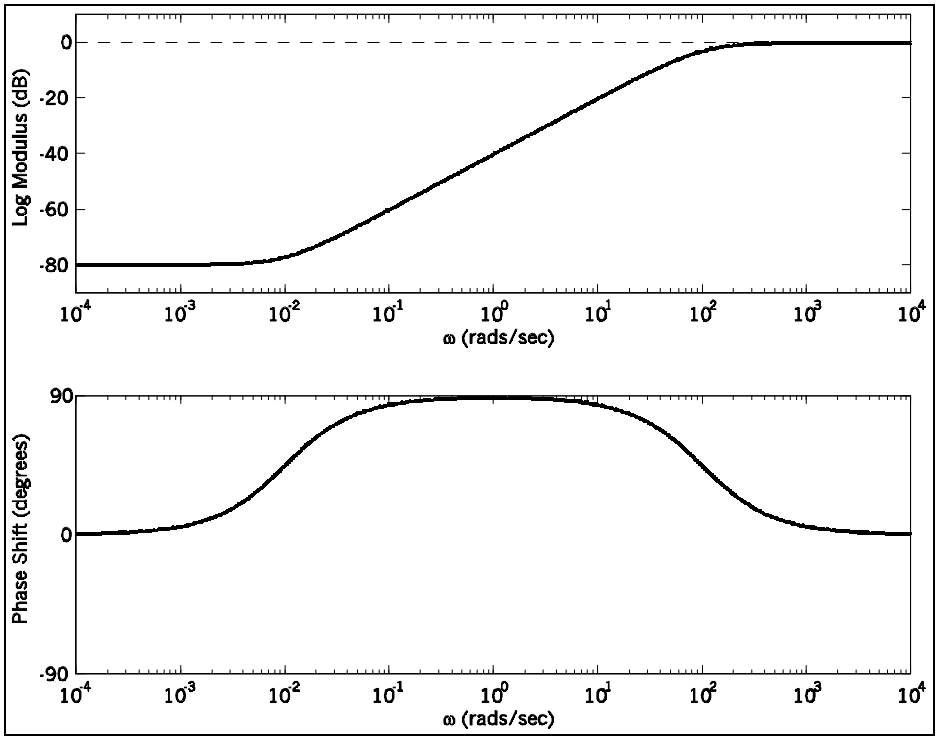

Figure 6. Bode plot for Case 3.

5. Bonus (10 pts). Consider a circle contour Γ of radius 1 and centered at (-1,0) in the *s*-plane as shown in Figure 7. Find the number of clockwise encirclements of the origin that the map of

$$G = \frac{s+1}{(s+1)^2 + 0.5^2}$$

will have as *s* traverses Γ in the clockwise manner.