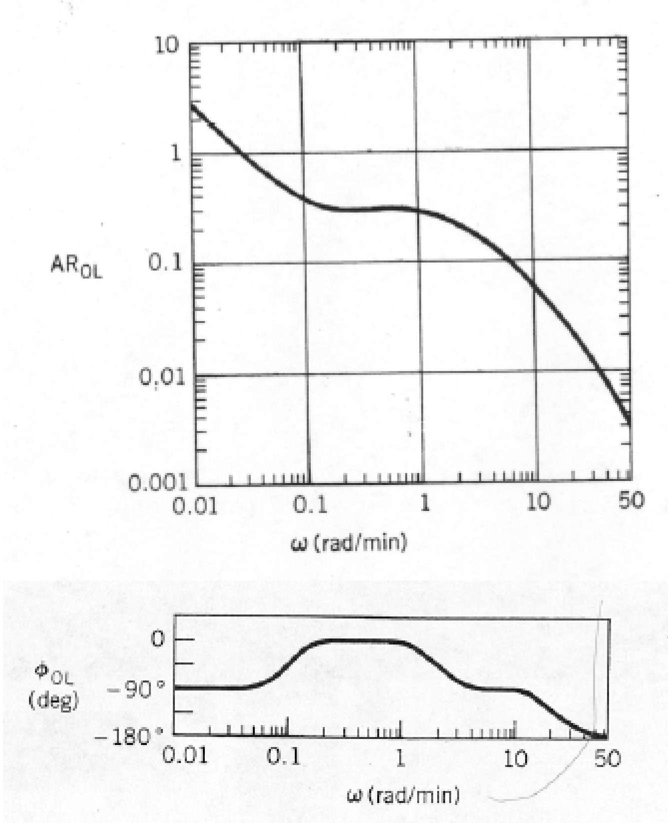
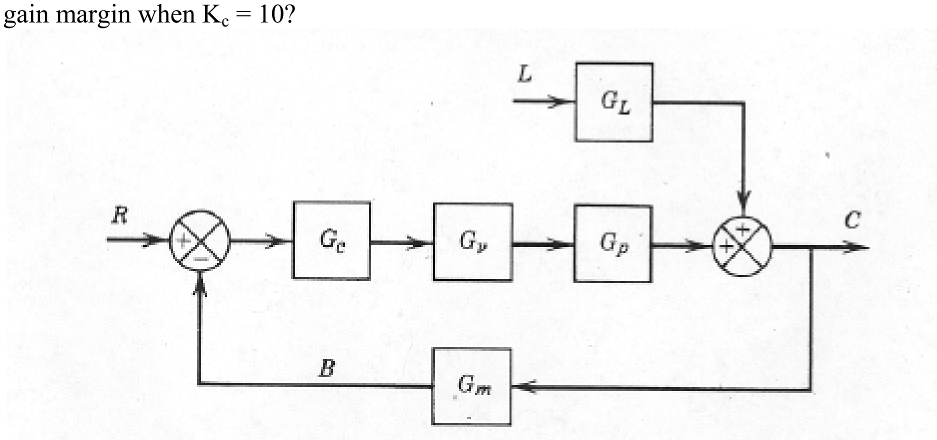
ChEE 413
Homework Handout 12
Spring 2005

1) Problem 16.5 from first edition - A Bode diagram for a process, valve and sensor is shown in the drawing:



a) determine an approximate transfer function for this system
b) suppose that a proportional controller is used and that a value of K_c is selected so as to provide a gain margin of 1.7. What is the phase margin?

2) Problem 16.9 from first edition - For the feedback control system shown in the drawing, do the following:
a) plot a Bode diagram for the open loop system, B/R.
b) calculated the value of K_c that will provide a phase margin of 30°.
c) what is the gain margin when K_c = 10?



3) Problem 16.12 from first edition - The block diagram of a conventional feedback control system contains the following transfer functions:

$$G_c = K_c\left(1+\frac{1}{5s}\right) \qquad G_v = 1 \qquad G_m = \frac{1}{s+1} \qquad G_p = G_L = \frac{5e^{-2s}}{10s+1}$$

a) plot the Bode diagram for the open loop system (G_{OL})
b) For what values of K_c is the system stable?
c) If $K_c = 0.2$, what is the phase margin?
d) What value of K_c will result in a gain margin of 1.7?

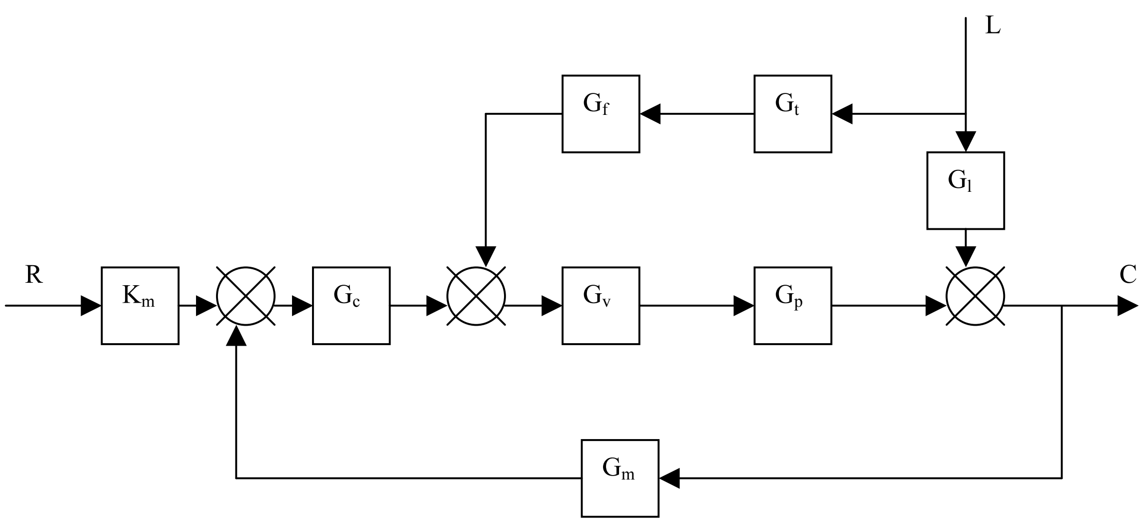
4) Problem 16.15 from first edition - Consider a standard feedback control system with the following transfer functions:

$$G_m = e^{-0.5s} \qquad G_v = \frac{-10}{s+1} \qquad G_p = \frac{1.5}{10s+1} \qquad G_L = \frac{2}{6s+1}$$

a) plot the Bode piagram for the transfer function $G = G_vG_pG_m$
b) Design a PI controller for this process and sketch the asymptotic Bode diagram for the open loop transfer function $G_{OL} = G_cG$.
c) Analyze the stability of the resulting feedback control system.
d) suppose that under open loop contiditons, a sinusoidal set point change R(t) = 1.5 sin(0.5t) is introduced. What is the amplitude of the measured output signal B(t) that is also sinusoidal in nature?
e) repeat the same analysis for closed loop contitions
f) compare and discuss your results of parts (d) and (e).

5) Problem 17.7 b and d from first edition - The closed loop system in the diagram has the following transfer functions:

$$G_p(s) = \frac{1}{s+1} \qquad G_L(s) = \frac{2}{(s+1)(5s+1)} \qquad G_v(s) = G_m(s) = G_t(s) = 1$$



b) design a feedforward controller based on a dynamic analysis
d) calculate and plot the closed loop response to a unit step change in the load variable using feedforward control only and the controller of part b.