Massachusetts Institute of Technology
Department of Mechanical Engineering

2.010 Modeling, Dynamics, and Control III
Spring 2002

Reading Nise
Chapter 10
10.1, 10.2, 10.7, 10.8
Chapter 11
11.1 and 11.2

Problem Set # 10
Due Friday, May 3, 2002

Problem 1
Determine the transfer function of the system whose Bode plots are given in Figure P10.10 on p. 677 in the Nise textbook. Repeat for the Bode plots shown in Figure P10.11.

Problem 2
Sketch Bode plots for the following open-loop transfer function with K = 800, and find the gain margin, phase margin, zero dB frequency and 180° frequency. Determine the range of K for which the system is stable by imagining the magnitude plot sliding up or sown until instability results.

$$G(s) = \frac{K(s+0.5)}{s(s+100)(s+2)^2}$$

Problem 3
To examine stability margins of the system shown in Figure 3(a), the feedback loop was disconnected at the summing junction, and a sinusoidal input was applied to the controller, as shown in Figure 3(b). Answer the following questions:

(a) When the input frequency was 25 Hz, the output was 180 out of phase as shown in Figure 3(c). What is the gain margin of this system?

(b) When the input frequency was decreased to 18 Hz, the output magnitude became the same as the input magnitude, as shown in Figure 3(d). What is the phase margin of this system.

Problem 4
Nise Problem 10-38

Problem 5
Nise Problem 10-39

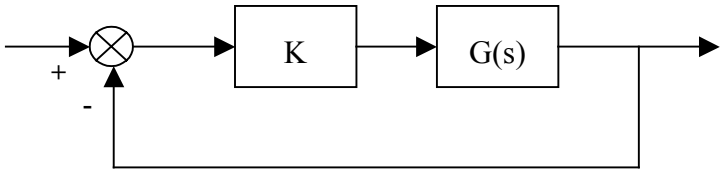

Figure 3(a): Feedback Control System

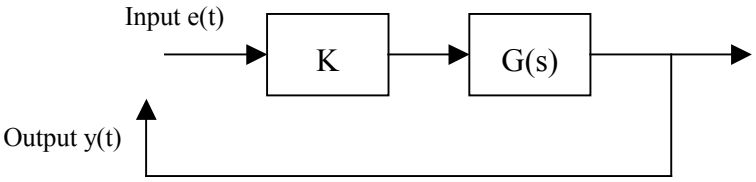

Figure 3(b): System with Feedback loop disconnected

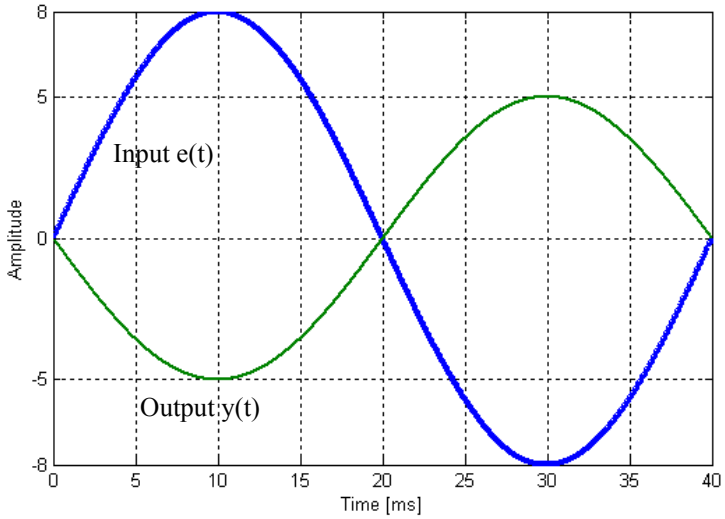

Figure 3(c)

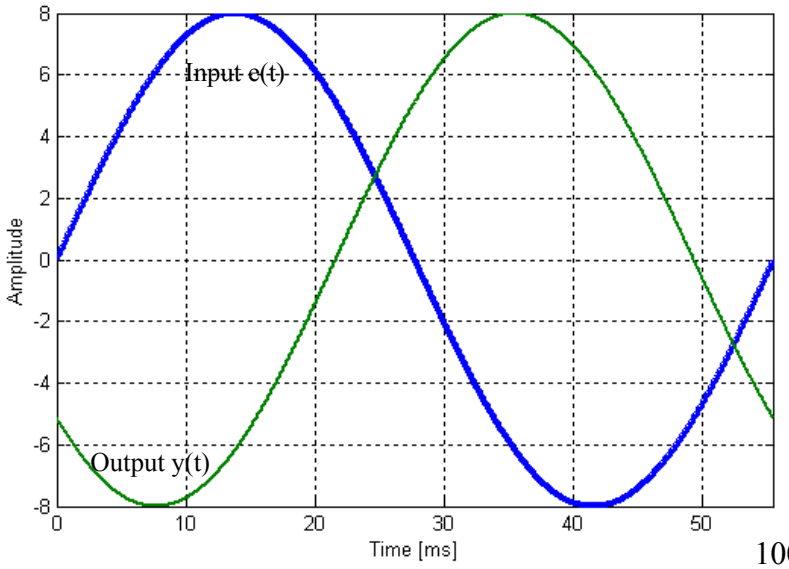

Figure 3(d)

$$\frac{1000}{18}$$