EE 123 DIGITAL SIGNAL PROCESSING, Spring 2009
Homework # 8, Due April 9, Thursday

1. Problem 4.29, Oppenheim and Schafer, 2nd ed.
2. Problem 4.32, Oppenheim and Schafer, 2nd ed.
3. Problem 4.34, Oppenheim and Schafer, 2nd ed.
4. Problem 4.37, Oppenheim and Schafer, 2nd ed.
5. An engineer has designed the digital controller:

$$D(z) = 0.17\frac{z-0.9}{z-0.4}$$

with sampling period $T = 1$ sec for a continuous-time plant modeled by the transfer function:

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

The resulting control scheme is depicted in the block diagram below, where $r(t)$ is the reference signal to be tracked by the output $y(t)$. Because the measurement noise $n(t)$ contains only high frequencies, the engineer expects it to be filtered out by the plant. However, he observes low frequency oscillations in the output $y(t)$. To see this phenomenon:

a) Implement the block diagram in MATLAB SIMULINK to obtain the response $y(t)$ when $r(t)$ is a unit step and $n(t) \equiv 0$.

b) Repeat the simulation with measurement noise $n(t) = 0.1\sin(10.2\pi t)$. You should observe ripples in the output $y(t)$. What is the frequency of these ripples and how does it relate to the frequency of the noise signal?

c) What would you tell the engineer to add to his control loop to eliminate these ripples?