B-5-1. Time constant = 0.25 min. The steady-state error is 2.5 degrees.

B-5-2.

Rise time = 2.42 sec

Peak time = 3.63 sec

Maximum overshoot = 0.163

Settling time = 8 sec (2 % criterion)

B-5-3. The maximum overshoot of 5% corresponds to $\zeta = 0.69$. Hence

$$\omega_n = \frac{2}{\zeta} = \frac{2}{0.69} = 2.90 \text{ rad/sec}$$

B-5-4.

$$\frac{C(s)}{R(s)} = \frac{K(Ts+1)}{Js^2 + KTs + K}$$

Since T = 3, K/J = 2/9, we have

$$\frac{C(s)}{R(s)} = \frac{\frac{2}{9}(3s+1)}{s^2 + \left(\frac{2}{9}\right)3s + \frac{2}{9}}$$

Hence, $2\zeta\omega_n = 6/9$ and $\omega_n^2 = 2/9$. Thus

$$\zeta = 0.707$$

B-5-10. For the given system we have

$$\frac{C(s)}{R(s)} = \frac{K}{s^2 + 2s + Kks + K}$$

Note that

$$K = \omega_n^2 = 4^2 = 16$$

Since

$$2\zeta\omega_n = 2 + Kk$$

we obtain

$$2 \times 0.7 \times 4 = 2 + Kk = 2 + 16k$$

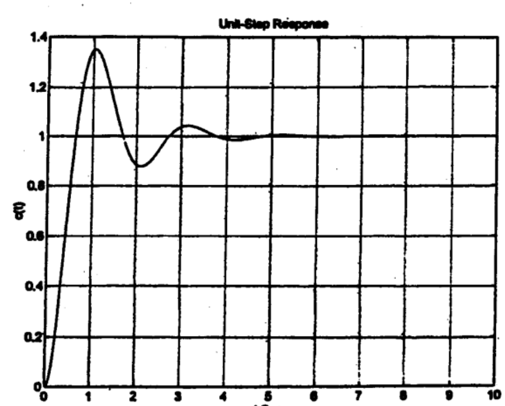
Thus

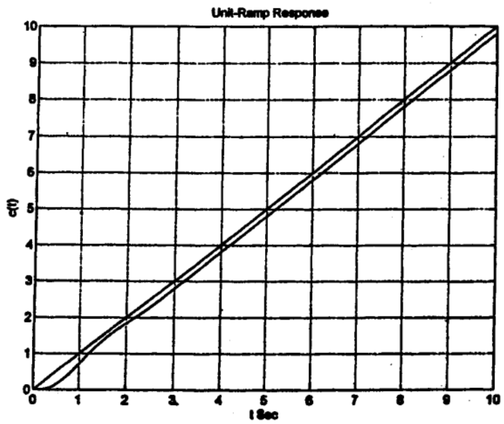
$$k = 0.225$$

5-12:

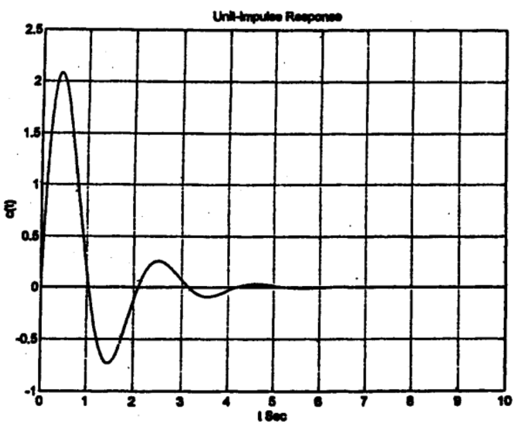
```
% ***** Unit-step response *****

num = [0  0  10];
den = [1  2  10];
t = 0:0.02:10;
step(num,den,t)
grid
title('Unit-Step Response')
xlabel('t Sec')
ylabel('c(t)')

% ***** Unit-ramp response *****

numr = [0  0  0  10];
denr = [1  2  10  0];
c = step(numr,denr,t);
plot(t,c,'-',t,t,'--')
grid
title('Unit-Ramp Response')
xlabel('t Sec')
ylabel('c(t)')

% ***** Unit-impulse response *****

impulse(num,den,t)
grid
title('Unit-Impulse Response')
xlabel('t Sec')
ylabel('c(t)')
```

The unit-step response curve is shown below. The unit-ramp response curve and unit-impulse response curve are shown on the next page.





Unit-Ramp Response
c(t)
t Sec



Unit-Impulse Response
c(t)
t Sec