Chapter 4, Problem 23

The poles of the system are located at -5, -.6 +/- j 1.57

Clearly, the added pole is more than 5 times farther from the Imaginary axis than the dominant second order poles.

We can approximate this as purely second order.

The dominant poles are at -.6 +/- j 1.57, which makes

Therefore,
wn=1.6820 and zeta=.3567

The relevant quantities are then easily found:
OS=30%
Ts=6.64 s
Tp=2 s

Chapter 4, Problem 24

a) From the graph, it is clear that the response reaches 63% of it's peak value at tau=.025 seconds (approx), which makes a=1/tau = 40.

The graph settles at 2 instead of 1, so the transfer function is 2 * a/(s+a), or

```
    2 * 40/ (s+40)
```

You can check this is correct by using the Laplace transform properties:

```
lim  s Output(s) = lim    Output(t)
s->0               t->inf
```

or

```
lim    s * 2 * 40
s->0      ------  =  2, which is where Output(t) settles
          s(s+40)
```

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b) From the graph, it is easy to measure that the maximum value is ~13.75. The final value is ~11. Therefore, the

overshoot is (13.75-11)/11 = 25%.

Also, the peak time is at ~1 second.

Using these values, we can calculate zeta=.4 by eq (4.39) and wn=3.43.

Therefore the denominator of the transfer function is (s^2 + 2*zeta*wn s + wn^2) = (s^2 + 2.744 s + 11.76).

Since the curve settles at 11, we can write the transfer function as

```
           11 * (11.76)                 129.36
G(s) = --------------------  =  ---------------------
       s^2 + 2.744 s + 11.76    s^2 + 2.744 s + 11.76
```