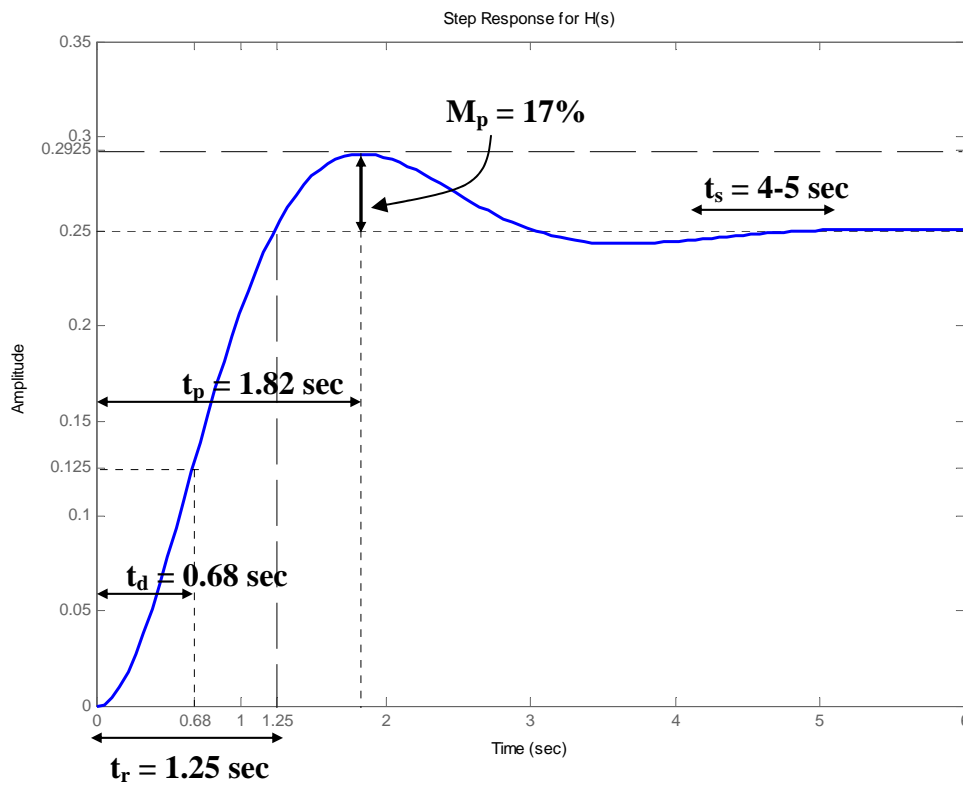


ECEN/MAE 3723 System I
Fall 2006
Solution for Computer Project

Problem 1: (Matlab Control Toolbox)

(a) $\overset{\dots}{y}(t) + 52\overset{\dots}{y}(t) + 104\overset{\cdot}{y}(t) + 200y(t) = 50u(t)$
 $s^3Y(s) + 52s^2Y(s) + 104sY(s) + 200Y(s) = 50U(s)$
$$\frac{Y(s)}{U(s)} = \frac{50}{s^3 + 52s^2 + 104s + 200}$$

(b)



(c)

Percentage Maximum overshoot

$$\begin{aligned}\% \text{ Max. Overshoot} &= \frac{y(t = \text{peak value}) - y(\infty)}{y(\infty)} \times 100\% \\ &= \frac{\sim 0.2925 - 0.25}{0.25} \times 100\% = \sim 17\%\end{aligned}$$

In the range of 15.5% to 17.5% is acceptable

Rise Time, t_r

In the range of 1.2 to 1.3 seconds is acceptable for response rise from 0% to 100%.

Delay Time, t_d

In the range of 0.6 to 0.75 seconds is acceptable

Peak Time, t_p

In the range of 1.7 to 1.85 seconds is acceptable.

Settling time, t_s

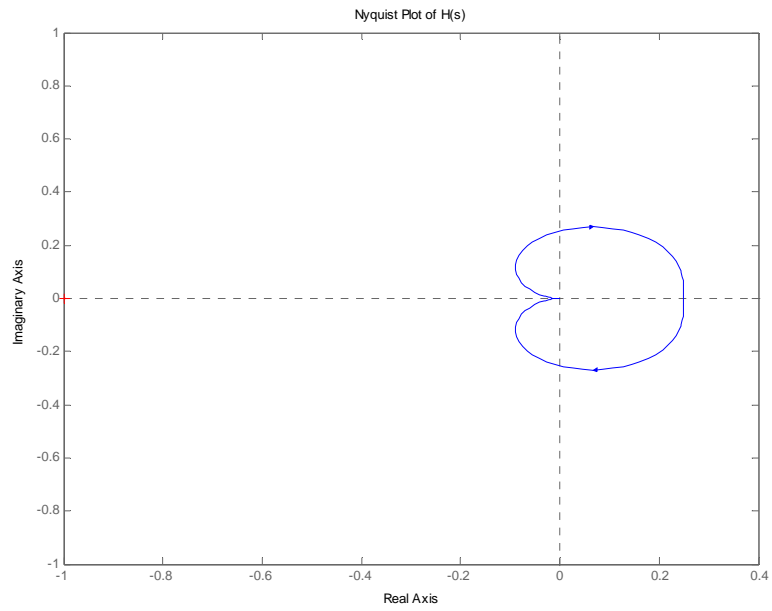
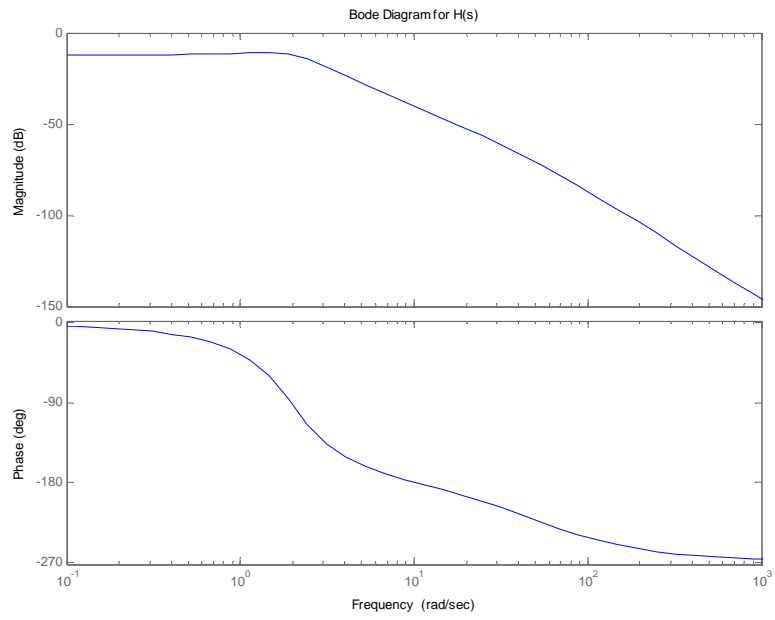
About 4 to 5 seconds.

Steady-State value

From the response, $y(\infty) = 0.25$

(d) FVT: $y(\infty) = \lim_{s \rightarrow 0} s \frac{50}{s(s^3 + 52s^2 + 104s + 200)} = 0.25$ (YES)

(e)



(f)

$$\begin{aligned} Y(s) &= \frac{1}{s} \times \frac{50}{s^3 + 52s^2 + 104s + 200} \\ &= 0.25 + \frac{A}{s+50} + \frac{B}{s+1-j1.7321} + \frac{B^*}{s+1+j1.7321} \\ &= 0.25 + \frac{0.0004}{s+50} + \frac{-0.1248-j0.0781}{s+1-j1.7321} + \frac{-0.1248+j0.0781}{s+1+j1.7321} \\ &= 0.25 + \frac{0.0004}{s+50} + \frac{-0.2496s-0.5202}{(s+1)^2+3} \\ &= 0.25 + \frac{0.0004}{s+50} - \frac{0.2496(s+1)}{(s+1)^2+3} - \frac{0.2706}{\sqrt{3}} \cdot \frac{\sqrt{3}}{(s+1)^2+3} \end{aligned}$$

$$\therefore y(t) = 0.25 + 0.0004e^{-50t} - 0.2496e^{-t} \cos(\sqrt{3}t) - \frac{0.2706}{\sqrt{3}}e^{-t} \sin(\sqrt{3}t)$$

The plot of $y(t)$ should be the same as the step response of $H(s)$ in Problem 1(b)

Matlab code

```
t=0:0.01:6;
y=0.25+0.0004*exp(-50*t)-0.2496*exp(-t).*cos(sqrt(3)*t)-
(0.2706/sqrt(3)).*exp(-t).*sin(sqrt(3)*t);
plot(t,y)
```

(g) Matlab code

```
G=1;
sys=feedback(H,G)
```

Matlab Output

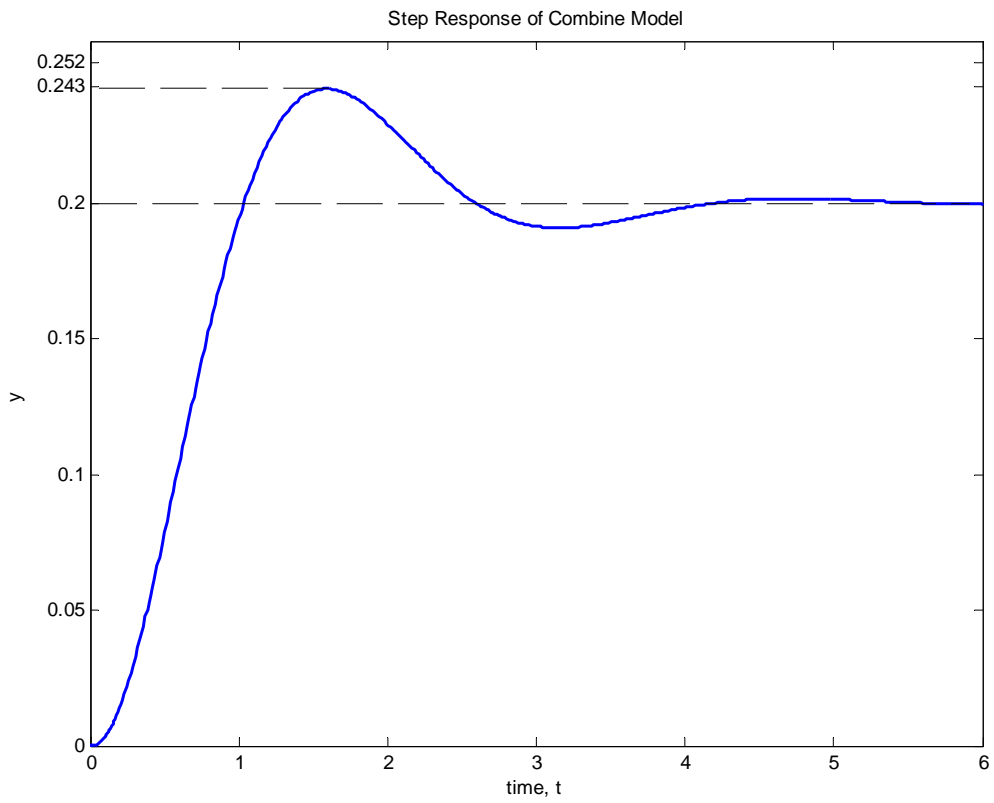
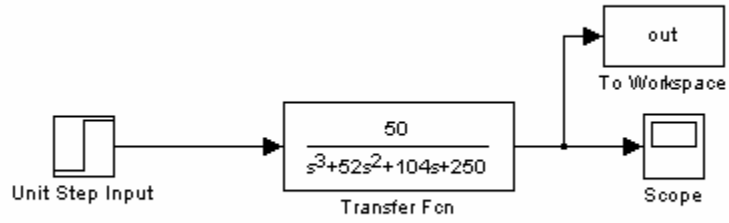
Transfer function:

50

s^3 + 52 s^2 + 104 s + 250

Problem 2: (Simulink)

(a)



(b) Compare the Specifications in Problem 1(c) with the current one (Problem 2(a)).

(c)

