Chapter 6

6.

s^6	1	-6	1	-6
s^5	1	0	1	
s^4	-6	0	-6	
s^3	-24	0	0	ROZ
s^2	ε	-6		
s^1	-144/ε	0		
s^0	-6			

Even (4): 2 rhp; 2 lhp; Rest (2): 1 rhp; 1 lhp; Total: 3 rhp; 3 lhp

21.

$$T(s) = \frac{K(s+6)}{s^3 + 5s^2 + (K+4)s + 6K}$$

s^3	1	4 + K
s^2	5	6K
s^1	20 -K	0
s^0	6K	0

Stable for $0 < K < 20$

33.

$$T(s) = \frac{5K(s+4)}{5s^3 + 16s^2 + (12+5K)s + 20K}$$

Making a Routh table,

s^3	5	12+5*K*
s^2	16	20*K*
s^1	192 - 20*K*	0
s^0	20*K*	0

a. For stability, $0 < K < 9.6$.

b. Oscillation for K = 9.6.

c. From previous row with K=9. 6, $16s^2 + 192 = 0$. Thus $s = \pm j\sqrt{12}$, or $\omega = \sqrt{12}$ rad/s.

44.

	1	K_2	1
s^3	K_1	5	0
s^2	$\frac{K_1K_2 - 5}{K_1}$	1	0
s^1	$\frac{K_1^2 - 5K_1K_2 + 25}{5 - K_1K_2}$	0	0
s^0	1	0	0

For stability, $K_1K_2 > 5$; $K_1^2 + 25 < 5K_1K_2$; and $K_1 > 0$. Thus $0 < K_1^2 < 5K_1K_2 - 25$,

or $0 < K_1 < \sqrt{5K_1K_2 - 25}$.

56.

$$T(s) = \frac{0.7K(s+0.1)}{s^4 + 2.2s^3 + 1.14s^2 + 0.193s + (0.07K+0.01)}$$

s^4	1	1.14	0.07K+0.01
s^3	2.2	0.193	0
s^2	1.0523	0.07K+0.01	0
s^1	0.17209 - 0.14635K	0	0
s^0	0.07K+0.01	0	0

For stability, $-0.1429 < K < 1.1759$