3.53:

a1 a2 a3 a4

a) $s^4 + 5.2s^3 + 18.9s^2 + 43.2s + 45.4$

s^4	1	18.9	45.4
s^3	5.2	43.2	0
s^2	10.6	45.4	0
s^1	20.9	0	0
s^0	45.4	0	0

No sign switches → [0]

b) $s^5 + .102s^4 + 1.123s^3 + 0.686s^2 + 0.154s + 2$

s^5	1	1.123	0.154
s^4	0.102	0.686	2
s^3	-5.6	-19.5	0
s^2	0.3	2	0
s^1	14.3	0	0
s^0	2	0	0

2 sign switches → [2]

c) $s^4 + 152s^3 + 12s^2 - 1932s - 4921$

s^4	1	12	-4921
s^3	152	-1932	0
s^2	24.7	-4921	0
s^1	28338	0	0
s^0	-4921	0	0

1 sign switch → [1]

d) $99s^3 - s^2 - 6s - 7$

s^3	1	$\frac{-6}{99}$
s^2	$\frac{-1}{99}$	$\frac{-7}{99}$
s^1	-7.1	0
s^0	$\frac{-7}{99}$	0

1 sign switch → [1]

e) $s^4 + 8s^2 + 36$

$(1s^4 + 8s^2 + 36)\frac{d}{ds} = [4, 16, 0]$

s^4	1	8	36
s^3	0	0	0
s^2			
s^1			
s^0			

↑ row of zeros

s^4	1	8	36
→ s^3	4	16	0
s^2	4	36	0
s^1	-20	0	0
s^0	36	0	0

2 sign switches → [2]

3.55: $KG(s) = \frac{k(s+6)}{s[(s+.7)(s+1.2)(s^2+1.8s+6)]}$

$1 + kG(s) = 0 \rightarrow s[(s+.7)(s+1.2)(s^2+1.8s+6)] + k(s+6) = 0$

$= s^4 + 2.7s^3 + 8.36s^2 + (12.072+k)s + 11.04$

→ using Routh's stability criterion

s^4	1	8.36	11.04
s^3	2.7	$(12.072+k)$	0
s^2	$\frac{10.5-k}{2.7}$	11.04	0
s^1	$\frac{-k^2-1.572k+46.3}{10.5-k}$	0	0
s^0	11.04	0	0

for the system to be stable;

$$\left(\left(\left(\frac{10.5-k}{2.7}\right) > 0\right) \& \left(\frac{-k^2-1.572+46.3}{10.5-k} > 0\right)\right) == 1$$

→ $k < 10.5$ & $-7.64 < k < 6.06$

→ $-7.64 < k < 6.06$

3.592

$s^4 + (10+k_2)s^3 + (121+k_1)s^2 + (k_1+k_1k_2+110k_2+210)s + (11k_1+110)$

for all coefs to be positive!

$k_2 > -10$, $k_1 > -121$, $k_1 > -9.09$, & $k_1+k_1k_2+110k_2 > -210$

$a_1 = 10+k_2$ $a_2 = 121+k_1$ $a_3 = k_1+k_1k_2+110k_2+210$ & $a_4 = 11k_1+110$

for Routh's stability criterion:

s^4	1	a_2 a_4
s^3	a_1	a_3 0
s^2	$\frac{a_1a_2-a_3}{a_1}$	a_4 0
s^1	c_1	0 0
s^0	a_4	0 0

$\frac{a_1a_2-a_3}{a_1} = b_1$

$\frac{a_3b_1-a_1a_4}{b_1} = c_1$

→ additionally $\frac{a_1a_2-a_3}{a_1} > 0$ & $\frac{a_3b_1-a_1a_4}{b_1} > 0$

→ $k_1 > -9.09$ & $k_2 > -1$