ECE 1673
HW#3 Solutions
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5.14. (a) $K_p = \lim_{s\to 0} G(s) = \frac{10}{3}$; type 0; step input: $e_{ss} = \frac{1}{1+10/3} = \underline{\frac{3}{13}}$
ramp input: $e_{ss} = \underline{\infty}$

(b) $K_v = \lim_{s\to 0} sG(s) = \frac{10}{6}$; type 1; step input: $e_{ss} = 0$
ramp input: $e_{ss} = \frac{1}{10/6} = 0.6$

(c) type 2; $\therefore$ no error for step input or ramp input

(d) $K_v = \lim_{s\to 0} sG(s) = \frac{10}{4}$; type 1: step input: $e_{ss} = 0$
ramp input: $e_{ss} = \frac{1}{10/4} = 0.4$

6.5. (a) $\lim_{s\to 0} H(s) = \lim_{s\to 0} \frac{1}{0.1s+1} = \underline{1}$

(b) $\lim_{s\to 0} (0.5s) = \underline{0}$

(c) type number = 1, from PI compensator

(d) $\Delta(s) = 1 + \frac{K(s+1)(0.5s)}{s(s+2)} + \frac{10K(s+1)}{s(s+2)(s+10)}$

$= 1 + \frac{0.5K(s^3+11s^2+10s) + 10Ks + 10K}{s^3 + 12s^2 + 20s}$

$\therefore$ Char. eq. $= 0 = [1+0.5K]s^3 + (12+5.5K)s^2 + (20+15K)s + 10K$

s^3	$1+0.5K$	$20+15K$
s^2	$12+5.5K$	$10K$
s^1	$(77.5K^2+280K+240)/(12+5.5K)$	
s^0	$10K$	$\Rightarrow K > 0$

$\therefore \underline{K > 0}$

6.8. C.E.: $1 + \frac{K(2-s)}{s^3+3s^2+5s+3} \Rightarrow \underline{s^3+3s^2+(5-K)s+(3+2K)=0}$

(a)

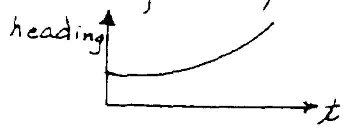
s^3	1	$5-K$
s^2	3	$3+2K$
s^1	$(12-5K)/3$	
s^0	$3+2K$	

$\Rightarrow K < 12/5 = 2.4$

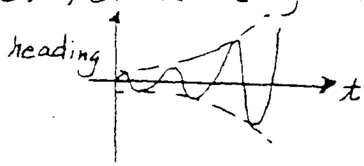
$\Rightarrow K > -\frac{3}{2} = -1.5$

$\therefore \underline{-1.5 < K < 2.4}$

(b) For $K<-1.5$, one root in r.h.p. This root must be real, $\therefore$ response term is of form ke^{at}, $a>0$.



(c) For $K > 2.4$, two complex roots in r.h.p.



(e) Let $r(t)=0$ & $d(t)=u(t)$, a unit step
$K=-1.6$; $K=2.5$