1906260600
Sze Kin Sang

FTE 3123 Mid - Term Test

1 (a)

$$\frac{C(s)}{R(s)} = \frac{K\left[\frac{20}{(s+1)(s+4)} \cdot \frac{1}{(s+2)}\right]}{1 + K\left[\frac{10}{(s+1)(s+4)}\right] + K\left[\frac{20}{(s+1)(s+4)} \cdot \frac{1}{(s+2)}\right]}$$

$$= \frac{K\left[\frac{20}{(s+1)(s+4)(s+2)}\right]}{1 + K\left[\frac{10s+40}{(s+1)(s+4)(s+2)}\right]}$$

$$\frac{60}{(s^3+7s^2+14s+8)}$$

The characteristics equation : $1 + K\left[\frac{10s+40}{(s+1)(s+4)(s+2)}\right] = 0$

$$(s+1)(s+4)(s+2) + 10Ks + 40K = 0$$

$$(s^3 + 7s^2 + 14s + 8) + 10Ks + 40K = 0$$

$$s^3 + 7s^2 + (14+10K)s + (40K+8) = 0$$

(b) Routh - array =

s^3 :	1	$(14+10K)$
s^2 :	7	$(40K+8)$
s^1 :	$\frac{30K-90}{7}$	
s^0 :	$40K+8$	

For the system to be stable, there should be any sign change.

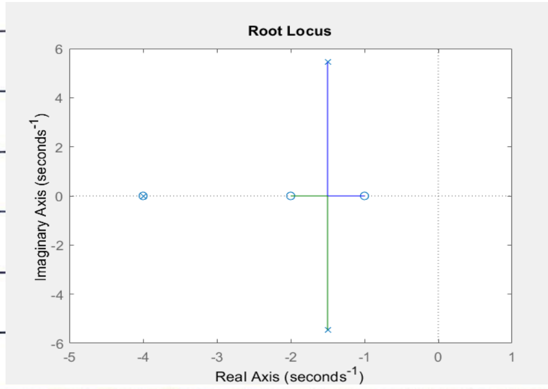
From s^1, $\frac{30K-90}{7} > 0$, $K > 3$

From s^0, $40K+8 > 0$, $K > -0.2$

$\therefore$ The range of K is $K > 3$

(c) When K = 3, the closed-loop system is marginally stable.

Root Locus :



When input = $\frac{1}{s}$, the system gives out :