Midterm Make-up points

11/12

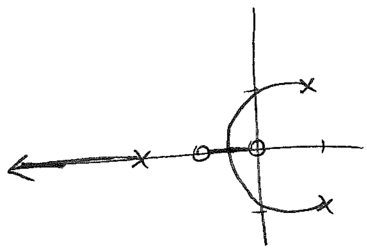
ECE 345. M. Qi

$\boxed{11}$ 1. (b) is correct.

2. $0 = \begin{vmatrix} \lambda & -1 \\ 0 & \lambda \end{vmatrix} = \lambda^2 \Rightarrow \lambda = 0, 0$

repeated eigvals at 0 $\Rightarrow$ unstable.

$\boxed{12}$ 1.



$n = 3,\ m = 2$

$n - m = 2 \Rightarrow 1$ asymptote

on real line at $+180°$.

$\therefore$ no need to calc. σ (centroid)

2. $\Delta(s) = (s+2)(s^2 - 2s + 2) + k \cdot s(s+1)$

$$= s^3 - 2s^2 + 2s$$
$$+ 2s^2 - 4s + 4$$
$$+ Ks^2 \quad + ks$$

$$= s^3 + ks^2 + (k-2)s + (4\ \ )$$

Hurwitz condition:

$$a_1 \cdot a_2 - a_0 > 0$$

$$(k-2) \cdot k - 4 > 0$$
$$k^2 - 2k - 4 > 0$$

boundary point: $k = \dfrac{+2 \pm \sqrt{2^2 + 4 \cdot 4}}{2} = 1 \pm \sqrt{5}$ and only

$1 + \sqrt{5} > 0$.

$\therefore \quad k > 1 + \sqrt{5}$ for stability

Routh table

s^3	1	$k-2$
s^2	k	4
s^1	$\dfrac{-\begin{vmatrix}1 & k-2\\ k & 4\end{vmatrix}}{k} = \dfrac{k^2-2k-4}{k}$	$\dfrac{-\begin{vmatrix}1 & 0\\ k & 0\end{vmatrix}}{k} = 0$
s^0	$\dfrac{\begin{vmatrix} k & 4 \\ \frac{k^2-2k-4}{k} & 0\end{vmatrix}}{-\left(\frac{k^2-2k-4}{k}\right)} = 4$	

$\therefore$ no sign change in 1st column of table for

$k^2-2k-4>0$ and

$k>0$.

$\Rightarrow k > 1+\sqrt{5}$.

3. Critically damped poles:

$0 = (s^2 + 2as + a^2)(s+b)$ for 2 poles at $s=-a$, 1 pole at $s=-b$

poles will be co-located at break-in point on the real line.

critically damped co-located poles.