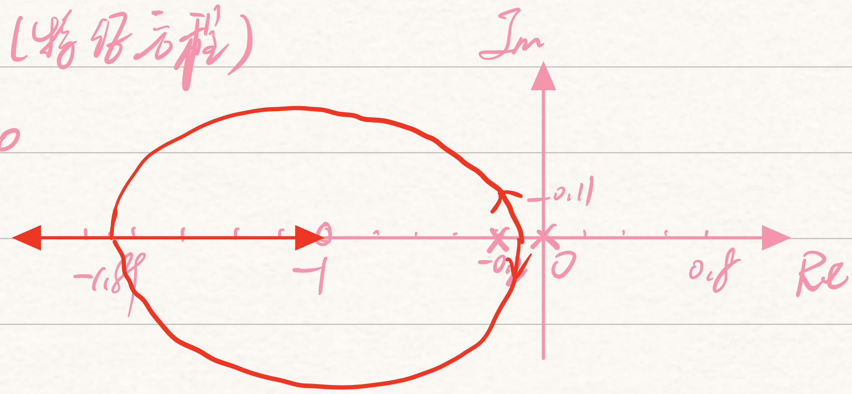
1. $G(S)=\frac{K(S+1)}{S(S+0.2)}$ 单位复反馈

CE: $1+G(S)=0$ (特征方程)



$\Rightarrow 1+K\frac{S+1}{S(S+0.2)}=0$

$P_1=0 \quad P_2=-0.2$

$Z=-1$

(3) 渐近线: $\sigma_a=\frac{\sum p_i-\sum z_i}{n-m}=0.8$

$\varphi_a=\frac{(2k+1)\pi}{n-m}=\pi$

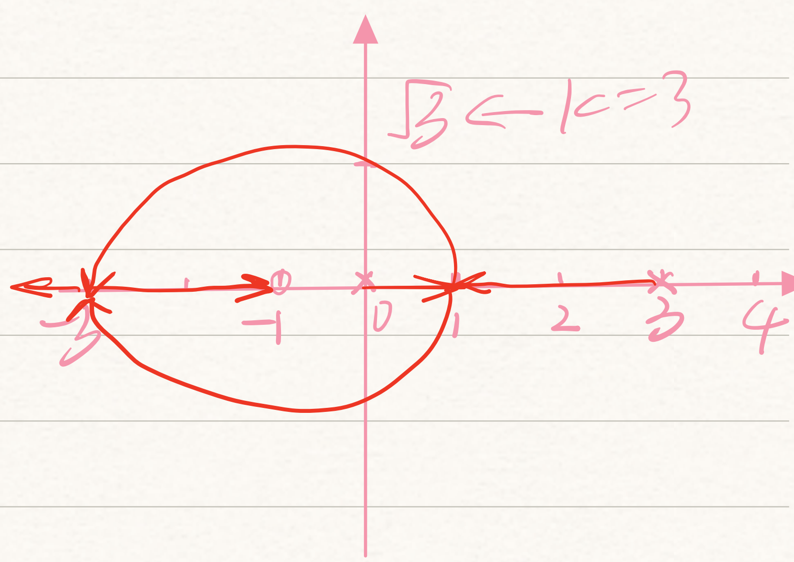
(5) $\sum_{i=1}^{n}\frac{1}{d-p_i}=\sum_{j=1}^{m}\frac{1}{d-z_i}$

$\frac{1}{d}+\frac{1}{d+0.2}=\frac{1}{d+1}$

$d=-1\pm 0.89$

$d=-0.11$ 或 -1.89 ∴两点均在根轨迹上

2. $G(S)=\frac{K(S+1)}{S(S-3)}$



$P_1=0, \quad P_2=3$

$Z_1=-1$

(2) 2条、

(3) $\varphi_a = \frac{(2k+1)\pi}{n-m} = \pi$

$\sigma_a = \frac{3-(-1)}{1} = 4$

(5) $\frac{1}{d-0} + \frac{1}{d-3} = \frac{1}{d+1}$

$d = -3, 1$

分离角 $\frac{\pi}{2}$

(7) $1+G(s)=0$

法一: $s^2+(k-3)s+k=0$

二阶 ~~稳定~~ 系数 都 > 0

s^2	1	k
s^1	$k-3$	0
s^0	k	

$k=3$

$s^2+3=0$

$s=\pm\sqrt{3}j$

法二: 令 $s=j\omega$

$-\omega^2-3\omega j+k\omega j+k=0$

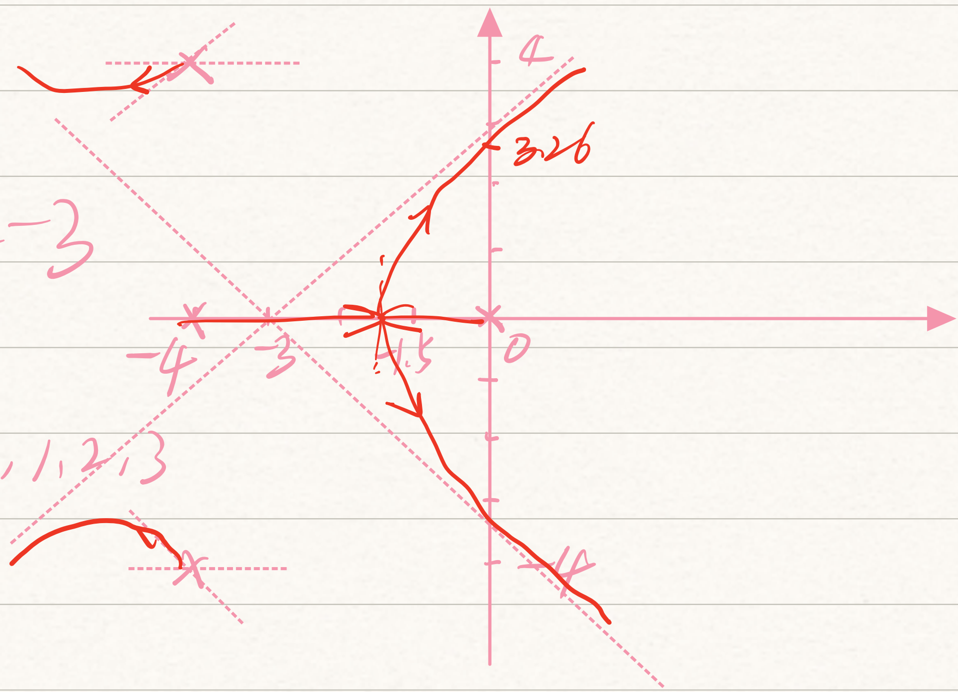
$\begin{cases} -\omega^2+k=0 \\ -3\omega+k\omega=0 \end{cases} \Rightarrow \begin{cases} k=3 \\ \omega=\pm\sqrt{3} \end{cases}$

3. $G(s) = \dfrac{K}{s^4+12s^3+64s^2+128s}$

$= \dfrac{K}{s(s+4)(s+4+4j)(s+4-4j)}$

$P_1=0$, $P_2=-4$, $P_3=-4-4j$, $P_4=-4+4j$

Z 不存在



(3) $\sigma_\alpha = \dfrac{-12}{4} = -3$

$\varphi_\alpha = \dfrac{2k+1}{4}\pi$, $k=0,1,2,3$

$= \dfrac{\pi}{4}, \dfrac{3\pi}{4}, \dfrac{5\pi}{4}, \dfrac{7\pi}{4}$

(5) 分离点
$$\begin{cases} s^4+12s^3+64s^2+128s+K=0 \\ 4s^3+36s^2+128s+128=0 \end{cases}$$

(6) $0-\left(\dfrac{3\pi}{4}+\dfrac{\pi}{2}+\dfrac{\pi}{2}+\theta\right)=(2k+1)\pi$

$\theta = -\dfrac{7}{4}\pi-(2k+1)\pi$

$= -\dfrac{3}{4}\pi$

$$s^4+12s^3+64s^2+128s+k=0$$

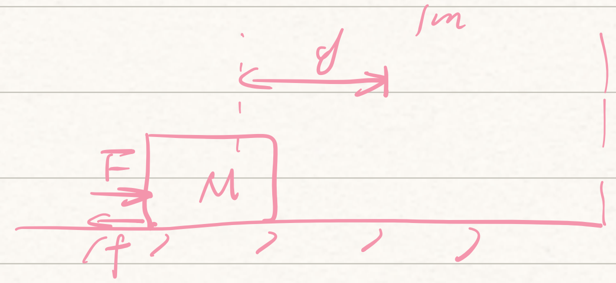
s^4	1	64	k
s^3	12	128	0
s^2	$\frac{160}{3}$	k	
s	$128-\frac{36k}{160}$	0	
s^0	k		

$$128-\frac{36k}{160}=0 \Rightarrow k=$$

$$\frac{160}{3}s^2+k=0$$

$$s=\pm\sqrt{\frac{3k}{160}}\,i$$

4.



$f=Bv=B\cdot\dot{y}$

$M=1\,kg \quad B=1$

$$Ma=F-f=F-B\dot{y}$$

$$M\ddot{y}=F(t)-B\dot{y}$$

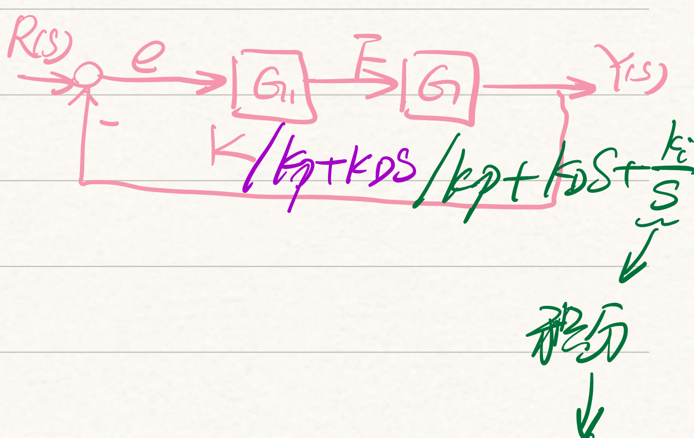
$$M\ddot{y}+B\dot{y}=F(t)$$

$$Ms^2Y(s)+BsY(s)=F(s)$$

$$\frac{Y(s)}{F(s)}=\frac{1}{Ms^2+Bs}$$

$$G=\frac{1}{Ms^2+Bs}$$

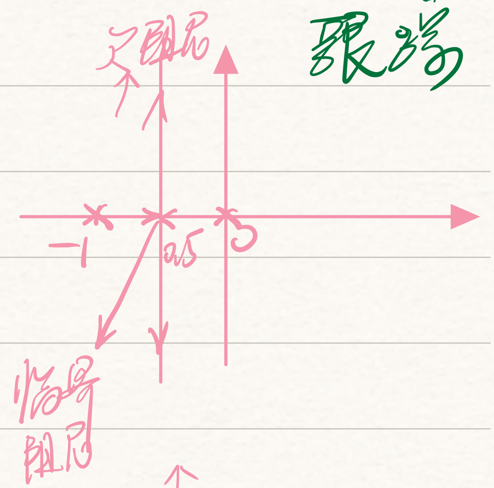
$$G_1=K$$



$$\frac{Y(s)}{}\quad G_1G$$

$$\frac{\ }{R(s)} = \frac{G_1G}{1+G_1G}$$

$$G_1G = \frac{k}{MS^2+BS} = \frac{k}{S(S+1)}$$

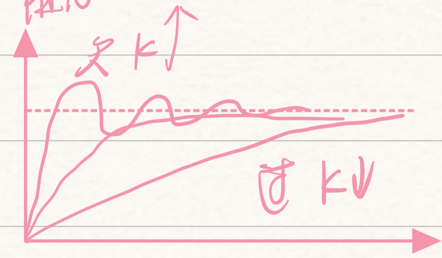


$$\frac{E(s)}{R(s)} = \frac{1}{1+G_1G_2}$$

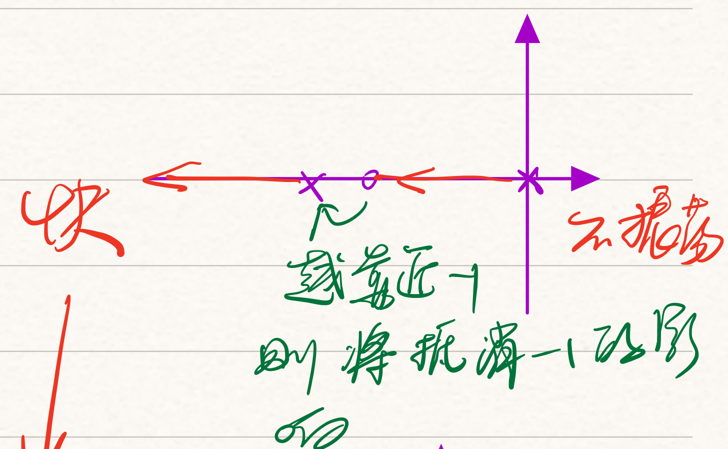
$$e(\infty) = \lim_{s\to 0} S \cdot \frac{1}{1+G_1G_2}\cdot\frac{1}{s} = 0$$

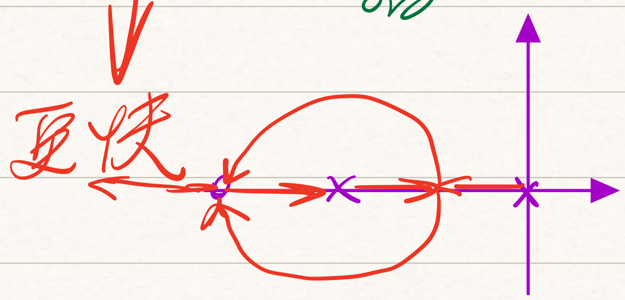
阶跃信号

无差跟踪

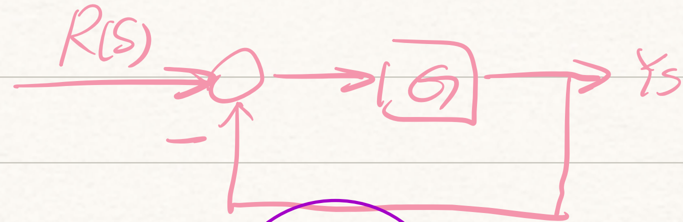


$$G_1G = \frac{K_P+K_DS}{S(1+S)}$$





5.



$$G = \frac{k}{S(S+a)}$$

$$1+G=0$$

只有根轨迹相同 不能用来分析系统动态和误差

定义 → 定义的 k

$s^2+as+k=0 \Rightarrow 1+\frac{as}{s^2+k}=0$

表 4-1 根轨迹图绘制法则

序号	内 容	法 则
1	根轨迹的起点和终点	根轨迹起于开环极点(包括无限极点)，终于开环零点(包括无限零点)
2	根轨迹的分支数、对称性和连续性	根轨迹的分支数等于开环极点数 $n(n>m)$，或开环零点数 $m(m>n)$ 根轨迹对称于实轴
3	根轨迹的渐近线	$n-m$ 条渐近线与实轴的交角和交点为 $\varphi_a=\frac{(2k+1)\pi}{n-m} \quad (k=0,1,\cdots,n-m-1)$ $\sigma_a=\frac{\sum_{i=1}^{n} p_i-\sum_{j=1}^{m} z_j}{n-m}$
4	根轨迹在实轴上的分布	实轴上某一区域，若其右方开环实数零、极点个数之和为奇数，则该区域必是根轨迹
5	根轨迹的分离点和分离角	l 条根轨迹分支相遇，其分离点坐标由 $\sum_{j=1}^{m}\frac{1}{d-z_j}=\sum_{i=1}^{n}\frac{1}{d-p_i}$ 确定；分离角等于 $(2k+1)\pi/l$
6	根轨迹的起始角与终止角	起始角：$\theta_{p_i}=(2k+1)\pi+\left(\sum_{j=1}^{m}\varphi_{z_jp_i}-\sum_{\substack{j=1\\(j\neq i)}}^{n}\theta_{p_jp_i}\right)$ 终止角：$\varphi_{z_i}=(2k+1)\pi-\left(\sum_{\substack{j=1\\(j\neq i)}}^{m}\varphi_{z_jz_i}-\sum_{j=1}^{n}\theta_{p_jz_i}\right)$
7	根轨迹与虚轴的交点	根轨迹与虚轴交点的 K^* 值和 ω 值，可利用劳斯判据确定
8	根之和	$\sum_{i=1}^{n}s_i=\sum_{i=1}^{n}p_i$

没零点时，求特征方程的导数为0时的根

有零点 部分再算

有n个K值这n次

(检验)