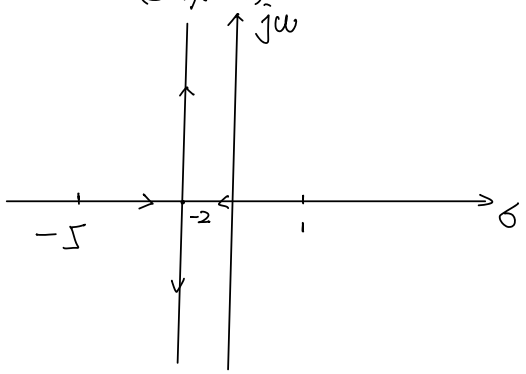
1、

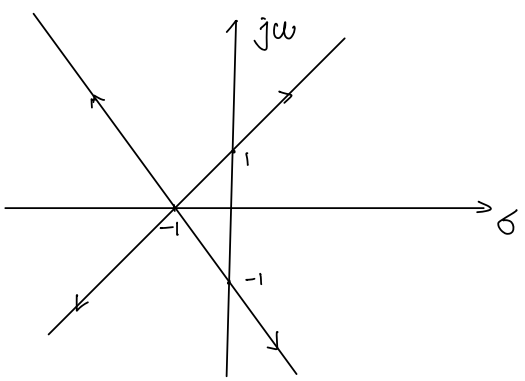
(a) $G(s)=\frac{k}{(s-1)(s+5)}$



与虚轴交点：$\omega=0$ $k=5$

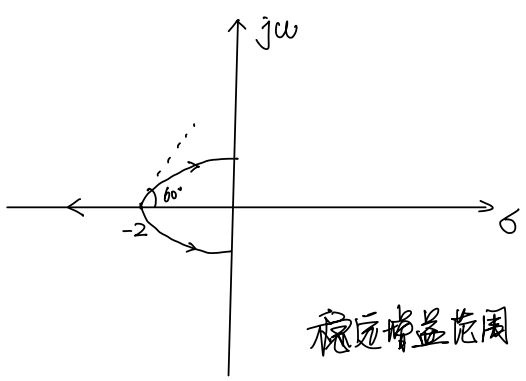
∴系统稳定的增益范围 $k>5$

(b)



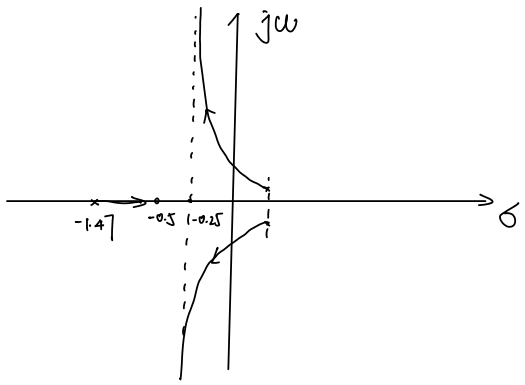
稳定增益范围：$k<4$

(c)



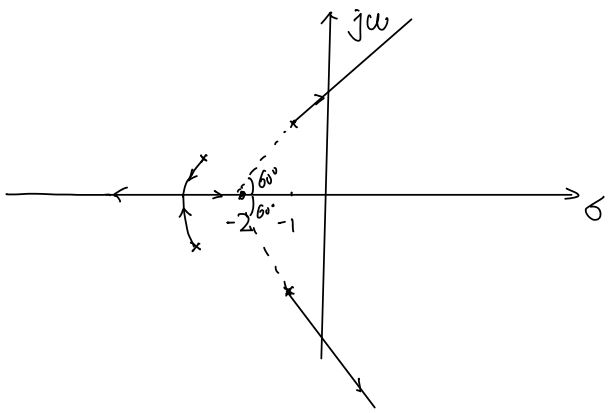
稳定增益范围 $k>0$

(d)



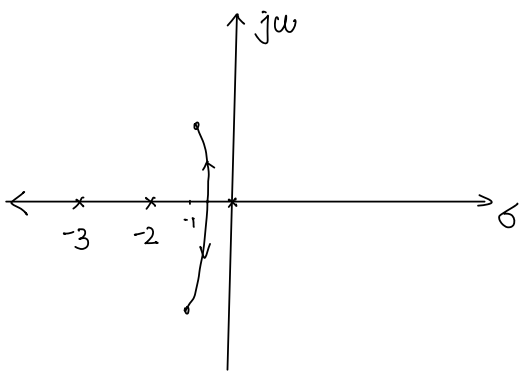
稳定增益范围 $K>2$

(e)



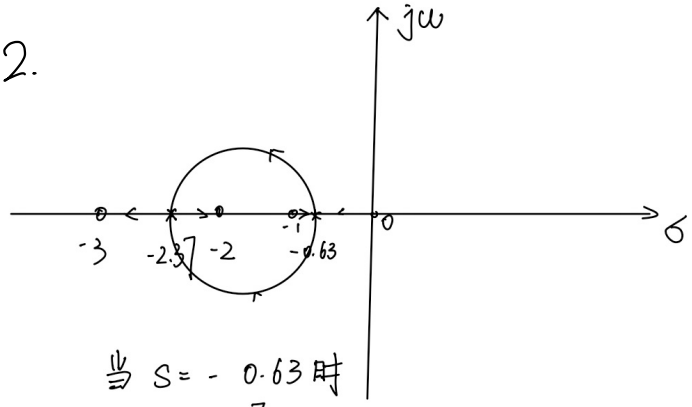
稳定增益范围为 $K<64.35$

(f)



稳定的增益范围 $K>0$

2.



当 $S=-0.63$ 时

$K=0.072$

当 $S=-2.37$ 时

$K=13.93$

∴ 当 K取 $(0, 0.072)$ $\cup$ $(13.93, +\infty)$ 时，为过阻尼系统

当 K取 $(0.072, 13.93)$ 时，欠阻尼

3. (a) $G_{o}(s)=\frac{4}{S(S+2)}$

主导极点 $S_{1,2}=-\zeta\omega_n \pm j\omega_n\sqrt{1-\zeta^2}=-2\pm j2\sqrt{3}$

校正后特征多项式：

$$S(S+2)(S+P)+4K_c(S+1)=0$$

$\therefore P=2.857$

$K_c=3.429$

(b) $G(S)=\frac{4}{S(S+2)}\cdot\frac{3.428(S+1)}{S+2.857}$

$$K_v=\lim_{S\to 0} SG(S)=2.4$$

∴ 超前校正装置传递函数零点和极点离原点越近，

静态误差系数越小

4. 应设计一个超前滞后校正.

$$K_v' = \lim_{s\to 0} sG_0(s) = 1$$

主导极点:

$S_d = -2 \pm 2\sqrt{3}j$

$K_v = 10\ s^{-1}$

$$G_c(s)G_p(s) = K_c \cdot \frac{s+\frac{1}{T_1}}{s+\frac{\beta}{T_1}} \cdot \frac{s+\frac{1}{T_2}}{s+\frac{1}{\beta T_2}} \cdot \frac{10}{s(s+2)(s+5)}$$

①: K_c:

$$K_v = \lim_{s\to 0} sG_c(s)G_p(s)$$

$$= K_c \cdot K_v' = 10$$

$$\Rightarrow K_c = 10$$

② 令 $T_2 \gg 1$

$$\therefore \left|\frac{s_d+\frac{1}{T_2}}{s_d+\frac{1}{\beta T_2}}\right| \approx 1$$

由幅值条件:

$$|G_p(s_d)G_c(s_d)| = 1$$

$$\Rightarrow \left|\frac{s_d+\frac{1}{T_1}}{s_d+\frac{\beta}{T_1}}\right| = 0.127$$

相角:

$$\arg\left[\frac{s_d+\frac{1}{T_1}}{s_d+\frac{\beta}{T_1}}\right] = 79.1°$$

考虑到要极点对消,

不妨令 $|OD| = 2$

则 $\frac{1}{T_1} = 2 \quad \frac{\beta}{T_1} = 20$

$\therefore T_2$ 满足:

$$\left|\frac{s_d+\frac{1}{T_2}}{s_d+\frac{1}{\beta T_2}}\right| = 1$$

$$-5° < \arg\left[\frac{s_d+\frac{1}{T_2}}{s_d+\frac{1}{\beta T_2}}\right] < 0°$$

取 $T_2 = 10$

$$\therefore \left|\frac{s_d+0.1}{s_d+0.01}\right| = 0.989$$

$$\arg\left[\frac{s_d+0.1}{s_d+0.01}\right] = -1.13°$$

$$\therefore G_c(s) = 10\frac{(s+2)(s+0.1)}{(s+20)(s+0.01)}$$