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HW 4

自控

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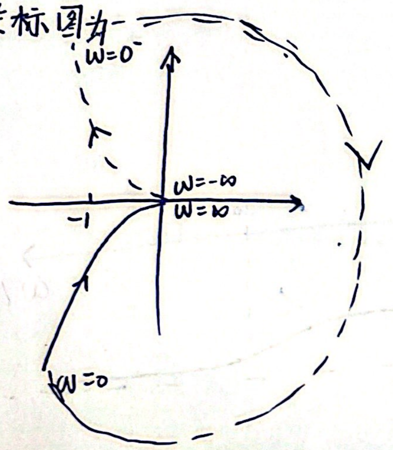
T4.

(1)

当$\omega=0$时 $G_0(j0)=\infty\angle-90^\circ$

当$\omega=\infty$时 $G_0(j\omega)=0\angle-180^\circ$

故极坐标图为



令$s=\varepsilon e^{j\theta}$，$\varepsilon\to0$.

当s从0^-到0^+时. θ从$-90^\circ\to0^\circ\to90^\circ$.

闭环系统稳定

~~(5) G w=0⁺~~

T5.

(1) $\omega=0$时. $G_0(j0)=K\angle0^\circ$

$\omega=\infty$时. $G_0(j\infty)=0\angle-270^\circ$

对应图(a) 两次包括(-1,0) 故不稳定

(2) $\omega=0$时 $G_0(j0)=\infty\angle-90^\circ$

$\omega=\infty$时 $G_0(j\infty)=0\angle-270^\circ$

对应图(b) 不包括(-1,0) 故稳定

(3) $\omega=0$时 $G_0(j0)=\infty\angle-180^\circ$

$\omega=\infty$时 $G_0(j\infty)=0\angle-270^\circ$

对应图(d) 两次包括(-1,0) 故不稳定

(4) $\omega=0$时 $G_0(j0)=-K\angle-180^\circ$

$\omega=\infty$时 $G_0(j\infty)=0\angle-90^\circ$

对应图(e) ~~一次~~ $m=N+n=-1+1=0$. 故稳定.

(5) $\omega=0$时 $G_0(j0)=\infty\angle-270^\circ$

$\omega=\infty$时 $G_0(j\infty)=0\angle-180^\circ$

对应图(f) $m=N+n=1+1=2$. 故不稳定.

(6) $\omega=0$时 $G_0(j0)=\infty\angle-270^\circ$

$\omega=\infty$时 $G_0(j\infty)=0\angle-90^\circ$

对应图(c) $m=N+n=1+1=2$. 故不稳定

T6.

(a) $m=N+n=1+1=2$，不稳定

(b) $m=N+n=-2+2=0$. 稳定

(c) $m=N+n=-2+2=0$. 稳定

(d) $m=N+n=-1+1=0$. 稳定

T7

(5)

① $20\lg 10 = 20$

$\angle K = 0^\circ$

② $\frac{1}{s}$: $-20\lg w$, $\phi = -90^\circ$

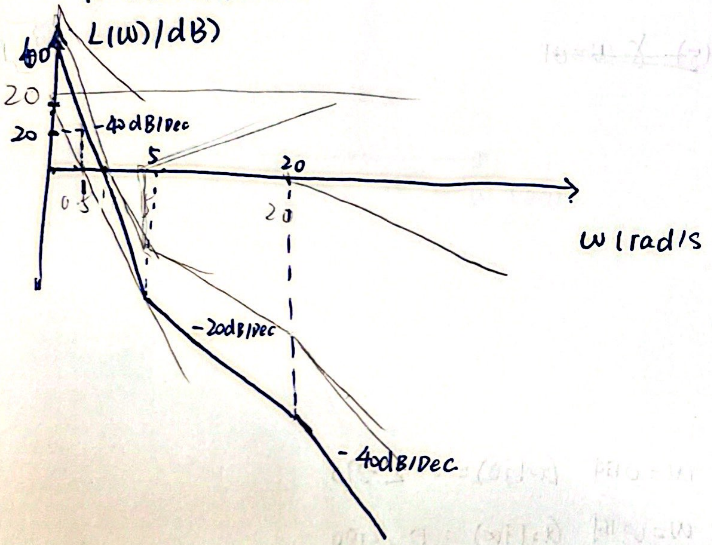
③ $\frac{1}{0.05s+1}$: $w \ll 20$, $L(w) = 0$. $\phi = 0$

$w \gg 20$, $L(w) = -20\lg wT$, $\phi = -90^\circ$

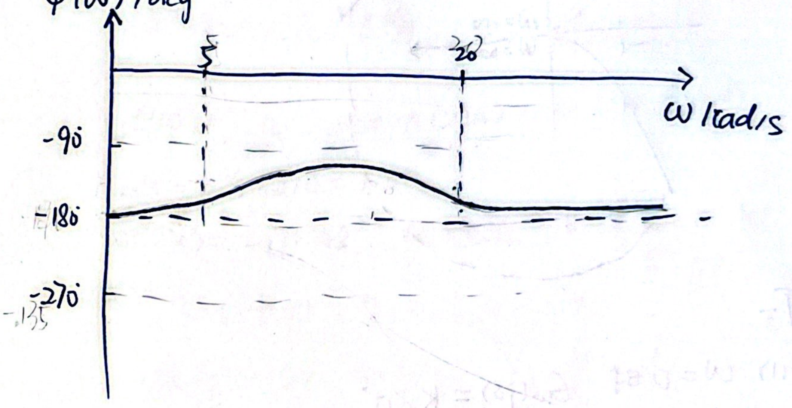
$w = \frac{1}{20}$, $L(w) = -3dB$. $\phi = -45^\circ$

④ $0.2s+1$: $w = 5$. $w \gg 25$. $L(w) = 20\lg wT$

故幅频为渐近线为



相频为



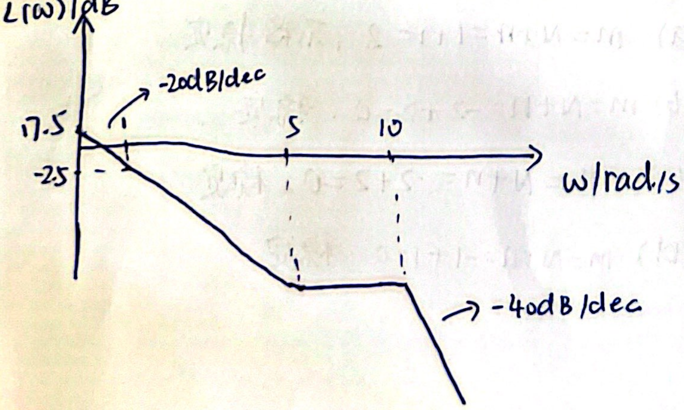
(6) ① ~~$20\lg 75 \approx 37.5$~~ ~~$\angle K = 0$~~ $20\lg\frac{75}{100} \approx -2.5$, $\angle K = 0^\circ$

② $\frac{1}{s}$: $-20\lg w$. $\phi = -90^\circ$

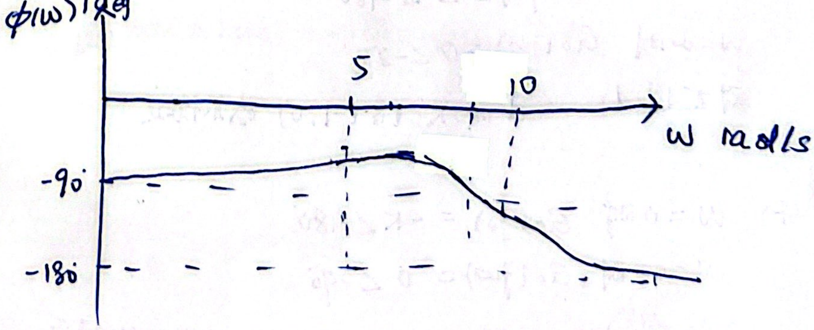
③ $0.2s+1$: $w = 5$.

④ $\frac{1}{s^2+16s+100} \Rightarrow \frac{\frac{1}{100}}{\frac{1}{100}s^2+\frac{4}{25}s+1}$, $w = 10$.

故幅频渐近线为



相频草图为



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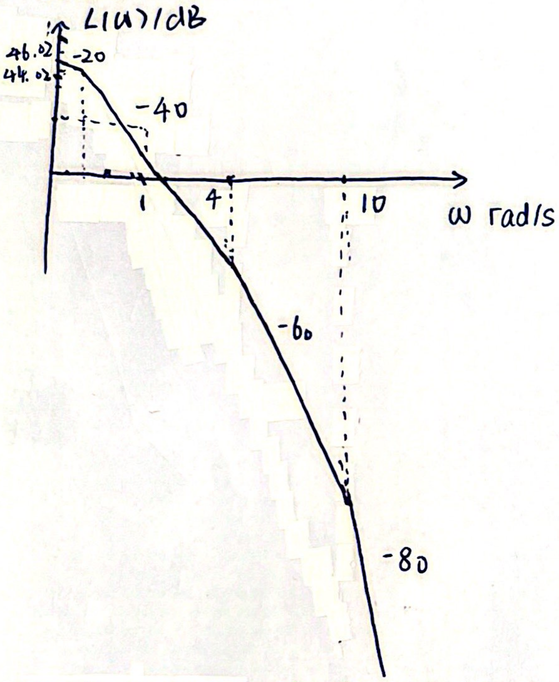
T8.(4)

(4) ① ~~θ~~ $20\lg 20 = 26.02$

② $\omega_1 = \frac{1}{10}$，$\omega_2 = 4$. $\omega_3 = 10$

故幅频渐近线为



$(\lg\omega_c - \lg 0.1)40 = 46.02$，$\omega_c = 1.4$

相角裕量

$\phi(\omega_c) = -90^\circ - \arctan(10\omega_c) - \arctan(0.25\omega_c) - \arctan(0.1\omega_c) = -203.17^\circ$

$\gamma = \phi(\omega_c) + 180^\circ = -23.17^\circ$

$\phi(\omega_g) = -90^\circ - \arctan(10\omega_g) - \arctan(0.25\omega_g) - \arctan(0.1\omega_g) = -180^\circ$，$\omega_g = 0.54$

幅值裕量

$K_g = -40(\lg 1.4 - \lg 0.54) = -16.55\ dB$

故系统不稳定

T10. (a)

$T_1 = \frac{1}{0.5} = 2$. $T_2 = \frac{1}{10} = 0.1$

~~当 $\omega = 0$.~~

$20 \times (\lg 0.5 - \lg 0.1) + 20 = 33.98\ dB$.

~~K=~~

$20\lg K = 33.98 - 20 = 13.98 \approx 5$

故开环传递函数为 $\frac{5}{s(2s+1)(0.1s+1)}$

$\phi(\omega) = -90^\circ - \arctan(2\omega) - \arctan(0.1\omega)$

$\omega_c = 0.5 \times \sqrt{10} = 1.58$

$\phi(\omega_c) = -171.42^\circ$，故稳定，$\gamma = \phi(\omega_c) + 180^\circ = 8.58^\circ$

(d) $T_1 = \frac{1}{1} = 1$. $T_2 = \frac{1}{2.5} = 0.4$

$20\lg K = 20$. $K = 10$

故开环传递函数为 $\frac{10(s+1)}{s(0.16s^2+0.8s+1)}$

~~$\phi(\omega)$~~ $(\lg\omega_c - \lg 2.5)40 = 20$，$\omega_c = 7.9$

$\phi(\omega_c) = -90^\circ + \arctan(\omega) - 2\arctan(0.4\omega)$
$= -152.09^\circ$

$\gamma = \phi(\omega_c) + 180^\circ = 27.91^\circ$，故稳定

T9.

(1) ~~$\phi(\omega_g) = -90^\circ - \arctan(T_1\omega_g)$~~

$\phi(\omega) = -90^\circ - \arctan(T_1\omega) - \arctan(T_2\omega)$ 单减.

当 K 增大时，ω_c 增大，故 $\phi(\omega_c)$ 减小

(2) $\phi(\omega) = -180^\circ + \arctan(T\omega)$ 单增.

当 K 增大时，ω_c 增大，故 $\phi(\omega_c)$ 增大