$\phi=-180^\circ$ 时. $-\frac{\pi}{2}=\arctan 3w+\arctan 0.1w$ $w=\frac{\pi}{2}$

$\arctan 3w=a$

$\arctan 0.1w=b$

$a+b=\frac{\pi}{2}$ $a=\frac{\pi}{2}-b$.

$\gamma=\phi=-\frac{\pi}{2}-\arctan 3w-\arctan 0.1w$

$\tan a=3w$

$\tan b=0.1w$ $w=\sqrt{\frac{1}{0.3}}$

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$1.8\,rad/s$

$\tan(\frac{\pi}{2}-b)=3w$

$\frac{1}{\tan b}=0.1w$ $0.3w^2$ $\sqrt{\frac{1}{0.3}}$

一、解：设通过L电流为$i_1(t)$，通过C电流为$i_2(t)$ 则有

$$\begin{cases} i(t)=i_1(t)+i_2(t) \\ u_o(t)=\frac{1}{C}\int i_2(t)dt \\ i_1(t)R=L\frac{di_2(t)}{dt}+\frac{1}{C}\int i_2(t)dt \end{cases}$$

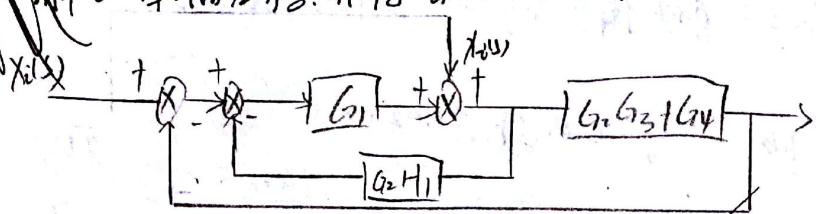
拉氏变换 $\Rightarrow$

$$\begin{cases} I(s)=I_1(s)+I_2(s) \\ U_o(s)=\frac{I_2(s)}{Cs} \\ I_1(s)\cdot R=Ls\,I_2(s)+\frac{I_2(s)}{Cs} \end{cases}$$

$\Rightarrow I(s)=\frac{LCs^2+1}{R}\cdot U_o(s)+Cs\,U_o(s)$

$\therefore G(s)=\frac{U_o(s)}{I(s)}=\frac{R}{LCs^2+RCs+1}$

二、解① 将A点左移，并将回路I化简有



$K_p=\lim\limits_{s\to 0}G(s)H(s)=\lim\limits_{s\to 0}\frac{10}{s(0.1s+1)(0.5s+1)}$ $=\infty$.

$K_v=\frac{10}{(0.1s+1)(0.5s+1)}=10$.

$K_a=\lim \frac{10s}{\ldots}=0$

② 当输入$X_i(s)$单独作用时：有 $\Phi_1(s)=\frac{X_o(s)}{X_i(s)}=\frac{\frac{G_1(G_2G_3+G_4)}{1+G_1G_2H_1}}{1+\frac{G_1(G_2G_3+G_4)}{1+G_1G_2H_1}}$

③ 当干扰$X_n(s)$单独作用时有 $\Phi_2(s)=\frac{X_o(s)}{X_n(s)}=\frac{\frac{G_2G_3+G_4}{1+G_1G_2H_1}}{1+\frac{G_2G_3+G_4}{1+G_1G_2H_1}}$

则 $\Phi(s)=\Phi_1(s)+\Phi_2(s)=\frac{G_1G_2G_3+G_1G_4}{G_1G_2G_3+G_1G_4+G_1G_2H_1+1}+\frac{G_2G_3+G_4}{G_2G_3+G_4+G_1G_2H_1+1}$

三、解(1) 由闭环特征方程式 $s^3+7s^2+17s+K=0$ 则稳定条件 $\begin{cases}K>0\\ 7\times 17>K\end{cases}$

$\therefore 0<K<119$

(2) 令 $s=z-2$ 代入得 $(z-2)^3+7(z-2)^2+17(z-2)+K=0\Rightarrow z^3+z^2+z+K-14=0$

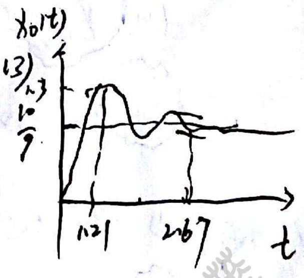
则 $\begin{cases}K-14>0\\ 1>K-14\end{cases}\Rightarrow 14<K<15$ $\Phi_e(s)=X_i(s)\frac{1}{1+G(s)}$

0	$\frac{1}{1+K_p}$	∞	∞
I	0	$\frac{1}{K_v}$	∞
II	0	0	$\frac{1}{K_a}$

四、解(1) 由 $G(s)\cdot\frac{1}{s}=\frac{1}{s}-\frac{1}{s+2}$ 有 $G(s)=\frac{2}{s+2}$ $e=\frac{1}{1+K_p}+\frac{1}{K_v}+\frac{1}{K_a}$

(2) $M_p=e^{-\frac{\pi\zeta}{\sqrt{1-\zeta^2}}}=e^{-\frac{\frac{1}{2}\pi}{\sqrt{1-\frac{1}{4}}}}=16.3\%$. $t_p=\frac{\pi}{w_n\sqrt{1-\zeta^2}}=\frac{\pi}{3\sqrt{1-(\frac{1}{2})^2}}=1.21s$

$\begin{cases}有\ G(s)=\frac{1}{s+2}\ X_i(s)=\frac{10}{s} \\ 则有\ \Phi(s)=\frac{1}{9}\cdot\frac{9}{s^2+3s+9}\end{cases}\Rightarrow\begin{cases}w_n=3\\ \zeta=\frac{1}{2}\end{cases}$ $t_s=\frac{4}{\zeta w_n}=\frac{4}{\frac{3}{2}}=1.67s$



(无制输入 样例说)

五、解：(1) $G_r(s)=0$ 时 单位负反馈 静态偏差系数等于静态误差系数 为I型系统

则 $K_p=\lim_{s\to 0}G(s)H(s)=\infty$ $K_v=\lim_{s\to 0}sG(s)H(s)=10$ $K_a=\lim_{s\to 0}s^2G(s)H(s)=0$

(2) 由输入信号 $x_i(t)=1+2t+3t^2$ 则 $A_1=1$ $A_2=2$ $A_3=3$ $X_2=6$ $\boxed{\frac{1}{s^{r+1}} \Longleftrightarrow \frac{1}{r!}t^r}$

由 $e_{ss}=\varepsilon_{ss}=\frac{A_1}{1+K_p}+\frac{A_2}{K_v}+\frac{A_3}{K_a}=\infty$

注：得比例 $\frac{X_o(s)}{X_i(s)}$ 后出来 写成为 $\Phi(s)=\frac{\Phi(s)}{1+\Phi(s)}$ 按出 $\Phi(s)$ 比较为 五至即为 s^3 外 其余都为0.

(3) $G_r(s)=as^2+bs$ 时 系统为 II 型系统 则 $K_p=K_v=K_a=\infty$

由此得 $E(s)=X_i(s)-X_o(s)$ 其中 $X_o(s)=[1+G_r(s)]\cdot\frac{G(s)}{1+G(s)}X_i(s)$

则 $E(s)=\frac{1-G_r(s)G(s)}{1+G(s)}\cdot X_i(s)$ 要使偏差等于误差等于0 有 $E(s)=0$

则 $G_r(s)=\frac{1}{G(s)}$ 即 $as^2+bs=\frac{s}{10}\cdot(0.1s+1)(0.02s+1)$

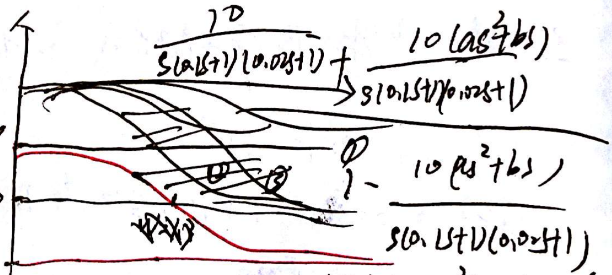
则 $a=0.012$ $b=0.1$ $\Phi(s)=\frac{G(s)}{1+G(s)}+\frac{G_rG_s}{1+G_s}=\frac{(1+G_r)G_s}{1+G_s}=\frac{\Phi(s)}{1+\Phi(s)}$

六、解：由闭环 $\Phi(s)=\frac{\frac{10}{5s^2+s}}{1+\frac{10}{5s^2+s}}=\frac{10}{5s^2+s+10}$ 则 $A(j\omega)=\frac{10}{\sqrt{\omega^2+(10-5\omega^2)^2}}=\frac{10}{\sqrt{4+100}}$

代入 $j\omega$ 有 $\Phi(j\omega)=\frac{10}{j\omega+10-5\omega^2}$ 则 $A=A(j\omega)\cdot A_0=\frac{10}{\sqrt{104}}\cdot 5=4.9$

$\phi(j\omega)=-\arctan\frac{\omega}{10-5\omega^2}$ 则 $\phi=\phi(j\omega)+\phi_0=-\arctan\frac{\omega}{10-5\omega^2}-60^\circ=-48.69^\circ$

输出 $x_o(t)=4.9\cos(2t-48.69^\circ)$



七、解：(1) 有 $G(s)=\frac{5}{s(\frac{1}{3}s+1)(\frac{1}{30}s+1)}$ (2)

(3) $-40\lg\frac{\omega_c}{3}=0-23.52\Rightarrow\omega_c=1.3\,rad/s$

$\frac{10+10as^2+10bs}{s(0.1s+1)(0.02s+1)-10as^2-10bs}=\frac{}{0.002s^3+0.12s^2+s+1}$

(4) $\phi_{\omega c}=-\frac{\pi}{2}-\arctan\frac{3\omega}{3}-\arctan\frac{\frac{1}{30}\omega}{1}=-\frac{\pi}{2}-\arctan 3.9-\arctan 0.13=$

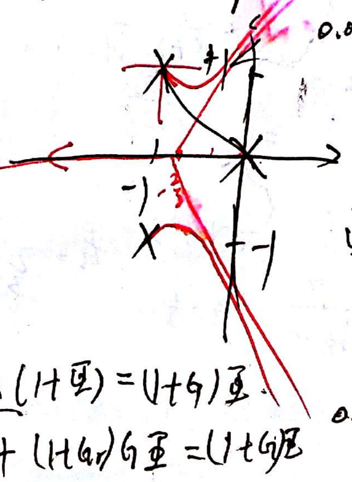
则 $\gamma=180^\circ+\phi_{\omega c}=$

八、解：(1) ① 起始角：$\phi=180^\circ-90^\circ-135^\circ=-45^\circ$

② 无分离点，③ 3条渐近线 $\phi_a=180^\circ, 180^\circ$ $\sigma_a=-\frac{2}{3}$

④ 与虚轴交点 $\omega=\pm\sqrt{2}$ 此时 $K^*=4$

(2) $0<K^*<4$



$\frac{G+GG_r}{1-GG_r}$

$\Phi=\frac{(1+G_r)G}{1+G-G\cdot G_r}$

$1-GG_r$

$(1+G_r)G(1+\Phi)=(1+G)\Phi$

$(1+G_r)G+(1+G_r)G\Phi=(1+G)\Phi$

$0.002s^3+0.12s^2+s-10as^2-10bs$

$0.12-10a=0$ $b=0.1$

$1-10b=0$ $a=0.012$