1. 解：(a). $\frac{4}{25}\phi''(t)+\frac{2}{5}\phi'(t)+\phi=u(t)$ 阻尼系数 $\zeta=\frac{1}{2}$，时间常数 $T=\frac{2}{5}$

$\therefore s_{1,2}=-\frac{5}{4}\pm j\frac{5\sqrt{3}}{4}$ $\phi(t)=1-\frac{2\sqrt{3}}{3}e^{-\frac{5}{4}t}\sin(\frac{5\sqrt{3}}{4}t+\frac{\pi}{3})$

(b). $T=\frac{2}{5}$. $\zeta=\frac{1}{2}$，无阻尼自然频率 $\omega_n=\frac{1}{T}=\frac{5}{2}$

(c). $t_s(5\%)=\frac{3T}{\zeta}=\frac{12}{5}s$. $\delta=e^{-\frac{\zeta\pi}{\sqrt{1-\zeta^2}}}=e^{-\frac{\sqrt{3}\pi}{3}}$

$t_r=\frac{\pi-\theta}{\omega_d}=\frac{8\sqrt{3}}{45}\pi s$

$\frac{1}{\sqrt{1-\zeta^2}}e^{-\frac{\zeta}{T}t_d}\sin(\omega_d t_d+\theta)=\frac{1}{2}$，matlab 解得值为 0.516.

即 $t_d=0.516s$

$t_p=\frac{\pi}{\omega_d}=\frac{4\sqrt{3}}{15}\pi s$

2. 解：(a). $G_{主1}(s)=\frac{\frac{1}{s}}{1+\frac{96.1}{s}}=\frac{1}{s+96.1}$ $G_{主2}(s)=\frac{\frac{1}{(s+96.1)}\cdot\frac{1}{(s+6)}}{1+\frac{-291.8}{(s+6)(s+96.1)}}$

$G_{主3}(s)=\frac{G_{主3}(s)\cdot\frac{1}{s+12}}{1+\frac{6582.4\,G_{主3}(s)}{s+12}}=\frac{1}{(s+12)[(s+6)(s+96.1)-291.8]+6582.4}\equiv\frac{1}{(s+6)(s+96.1)-291.8}$

$\therefore\frac{Y(s)}{W(s)}=\frac{10000}{(s+12)[(s+6)(s+96.1)-291.8]+6582.4}=\frac{10000}{(s+100)(s^2+14.1s+100)}$

(b). 主导极点即为 $s^2+14.1s+100$ 的两解：

$s_1=-7.05+7.09j$ $s_2=-7.05-7.09j$

(c). $\frac{Y(s)}{W(s)}=\frac{100}{s^2+14.1s+100}$