# 闭环对数频率特性绘制

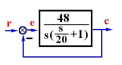
单位反馈 $G_K(s)=\frac{k}{s(T_1s+1)(T_2s+1)}$

$G_B(jw)=\frac{k}{jw(jT_1w+1)(jT_2w+1)+k}=M(w)e^{j\alpha(w)}$

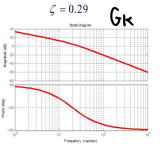
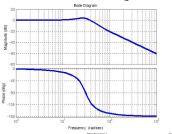
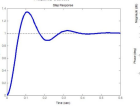
有等M圆、等N圆、Nichols图法，不作要求

# 闭环频率特性频域性能指标

## 1、一般闭环频率特性与时域性能关系




$\zeta=0.29$ $G_K$ $G_B$

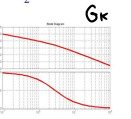




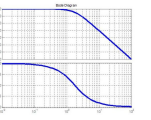
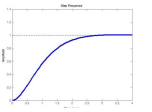
$G(s)=\frac{3}{s(s+3)}$

$G_B(s)=\frac{3}{s^2+3s+3}$

$\zeta=\frac{\sqrt{3}}{2}=0.866$

$G_K$ $G_B$



$G(s)=\frac{3}{s(s+3)}$

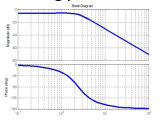
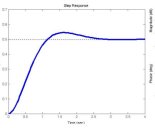
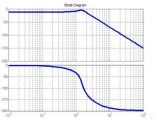
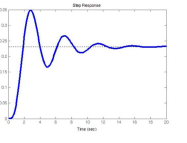
$H(s)=2$

$G_B(s)=\frac{3}{s^2+3s+6}$

$G(s)=\frac{3}{(s^2+s+2)(s^2+3s+5)},H=1$

$G_B(s)=\frac{3}{s^4+4s^3+10s^2+11s+13}$

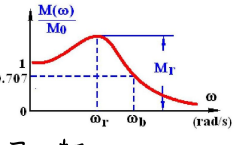
$G_K$ $G_B$ $G_K$ $G_B$

## 2、闭环频率特性几个特征量

① 零频值 $M_0=M(0)$

与时域闭环稳态值对应，$1(0)=k_B$ $(20\lg k_B)$



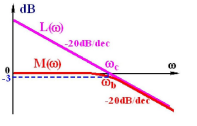

② 谐振频率 $w_r$ 和谐振峰值 $M_r$

二阶欠阻尼系统有 $w_r=w_n\sqrt{1-2\zeta^2}$，$M_r=\frac{1}{2\zeta\sqrt{1-\zeta^2}}$

③ 带宽频率 $w_r$：$M(w)$ 下降到 0.707 $M(0)$ 对应的频率值，用 $w_b$ 表示

## 3、闭环频率特性特征量与性能指标的关系

① 一阶系统 $G(s)=\frac{1}{Ts}$ $G_B(s)=\frac{1}{1+Ts}$

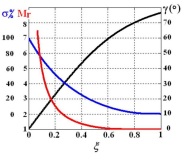


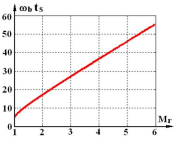

$w_c=\frac{1}{T}$，$w_b=\frac{1}{T}$，$t_s=3T=\frac{3}{w_c}=\frac{3}{w_b}$

② 二阶系统 $G_B(s)=\frac{w_n^2}{s^2+2\zeta w_n+w_n^2}$

$w_r=w_n\sqrt{1-2\zeta^2}$ $M_r=\frac{1}{2\zeta\sqrt{1-\zeta^2}}$ $(\zeta<0.707)$

$\sigma_p=e^{-\pi\sqrt{\frac{M_r-\sqrt{M_r^2-1}}{M_r+\sqrt{M_r^2-1}}}}$ $(M_r>1)$




$t_s=\frac{3}{\zeta w_n}$ $\frac{\sqrt{1-2\zeta^2}}{1-\zeta^2}$

$w_bt_s=\frac{3}{\zeta}\frac{\sqrt{1-2\zeta^2+\sqrt{2-4\zeta^2+4\zeta^4}}}{\sqrt{1-2\zeta^2+\sqrt{2-4\zeta^2+4\zeta^4}}}$ $M(w_b)=\frac{w_n^2}{\sqrt{(w_n^2-w_b^2)^2+(2\zeta w_nw_b)^2}}=0.707$

③ 高阶系统 $M_r\approx\frac{1}{\sin\gamma}$

$\sigma_p\%=[0.16+0.4(M_r-1)]\times100\%$

$t_s=\frac{\pi}{w_c}[2+1.5(M_r-1)+2.5(M_r-1)^2]$ $(1\le M_r\le1.8)$

$\sigma_p\%=[0.16+0.4(\frac{1}{\sin\gamma}-1)]\times100\%$

$t_s=\frac{\pi}{w_c}[2+1.5(\frac{1}{\sin\gamma}-1)+2.5(\frac{1}{\sin\gamma}-1)^2]$ $(35^\circ\le\gamma\le90^\circ)$