

$$5.16 \text{ 解: } G(s) = \frac{90}{s(0.1s+1)} = \frac{900}{s^2 + 10s}$$

$$\text{闭环 } \phi(s) = \frac{G(s)}{1+G(s)} = \frac{900}{s^2 + 10s + 900}$$

$$\text{由典型的二阶环节 } \omega_n = 900 \quad 2\zeta\omega_n = 10$$

$$\text{故 } \omega_n = 30 \quad \zeta = \frac{1}{6} < 0.7$$

$$\text{由 } \gamma \text{ 和 } \zeta \text{ 的关系 } \gamma = 100\zeta = 16.7^\circ$$

$$\text{开环特性 } G(j\omega) = \frac{900}{- \omega^2 + 10j\omega} \quad A(\omega) = \frac{900}{\sqrt{\omega^4 + (10\omega)^2}} = 1$$

$$\text{解得 } \omega_c = 29.2 \text{ rad/s}$$

$$\text{由于 } \zeta < 0.7, \text{ 由近似的关系 } \omega_b = \frac{\omega_c}{0.63} = 46 \text{ rad/s}$$

$$M_p = \frac{1}{2\zeta\sqrt{1-\zeta^2}} = 3.04 \quad \omega_p = \omega_n \sqrt{1-2\zeta^2} = 29.2 \text{ rad/s}$$

