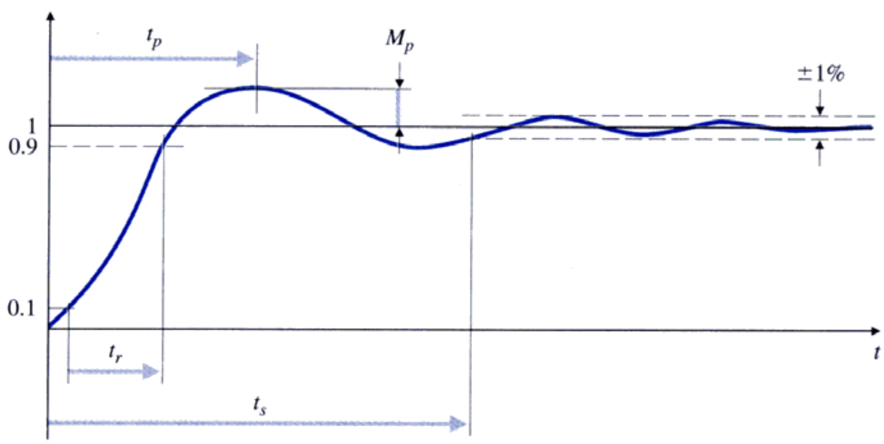
ME 343 – Control Systems

Lecture 08

September 9, 2009

Time Domain Specifications



Time Domain Specifications

1- The **rise time** t_r is the time it takes the system to reach the vicinity of its new set point
2- The **settling time** t_s is the time it takes the system transients to decay
3- The **overshoot** M_p is the maximum amount the system overshoot its final value divided by its final value
4- The **peak time** t_p is the time it takes the system to reach the maximum overshoot point

$$t_p = \frac{\pi}{\omega_n\sqrt{1-\zeta^2}} \qquad t_r \cong \frac{1.8}{\omega_n}$$

$$M_p = e^{-\pi\frac{\zeta}{\sqrt{1-\zeta^2}}} \qquad t_s = \frac{4.6}{\zeta\omega_n}$$

Time Domain Specifications

Design specification are given in terms of

$$t_r, t_p, M_p, t_s$$

These specifications give the position of the poles

$$\omega_n, \zeta \Rightarrow \sigma, \omega_d$$

Example: Find the pole positions that guarantee

$$t_r \leq 0.6\text{sec}, M_p < 10\%, t_s \leq 3\text{sec}$$

Time Domain Specifications

Additional poles:

1- can be neglected if they are sufficiently to the left of the dominant ones.

2- can increase the rise time if the extra pole is within a factor of 4 of the real part of the complex poles.

Zeros:

1- a zero near a pole reduces the effect of that pole in the time response.

2- a zero in the LHP will increase the overshoot if the zero is within a factor of 4 of the real part of the complex poles (due to differentiation).

3- a zero in the RHP (nonminimum phase zero) will depress the overshoot and may cause the step response to start out in the wrong direction.