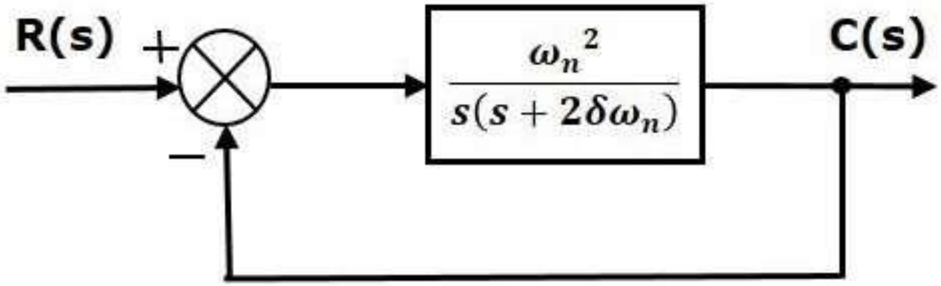
UNIT II

TIME DOMAIN SPECIFICATIONS

INTRODUCTION

- Consider the following block diagram of closed loop control system. Here, an open loop transfer function, $\frac{\omega_n^2}{s(s+2\zeta\omega_n)}$ is connected with a unity negative feedback.

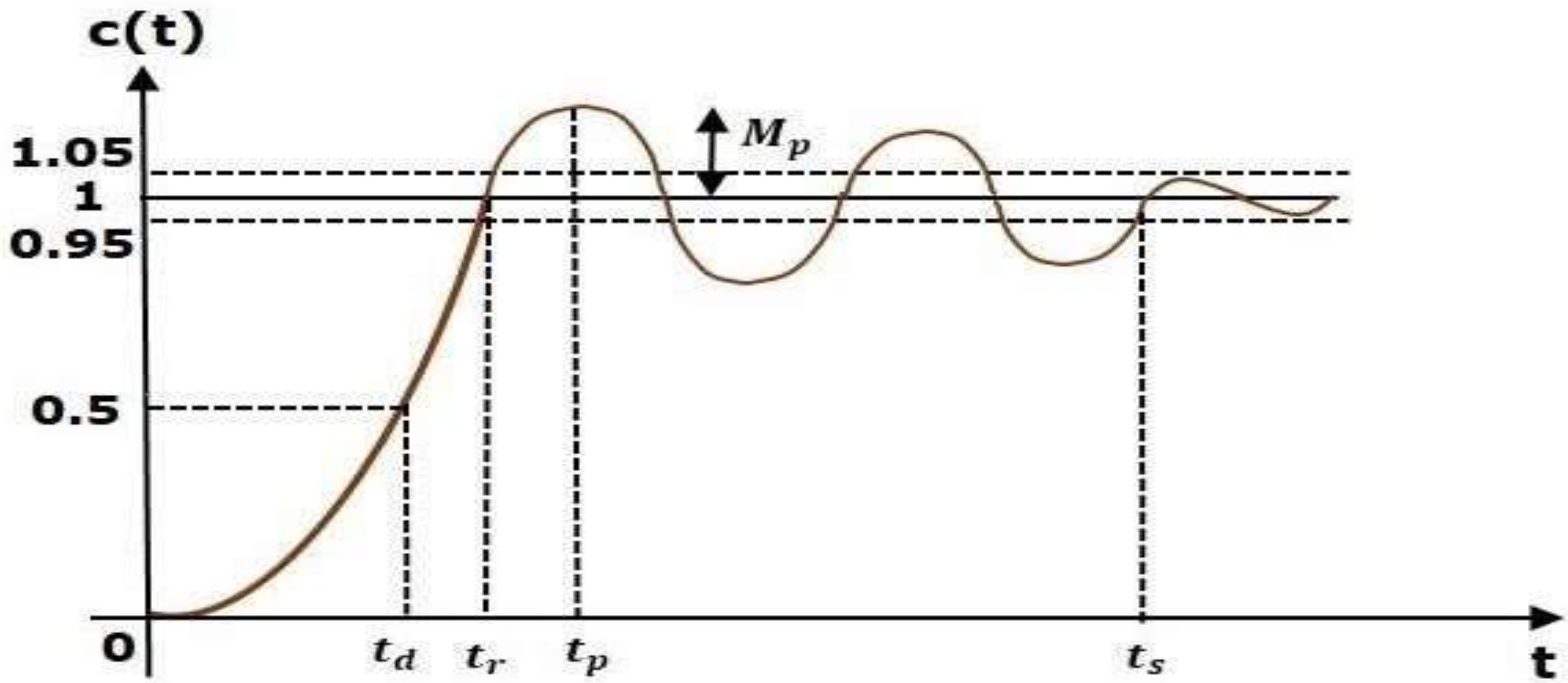


$$\frac{C(s)}{R(s)} = \frac{G(s)}{1+G(s)} = \frac{\omega_n^2}{s^2+2\delta\omega_n s+\omega_n^2}$$

INTRODUCTION

- The response of the system is given by,

$$c(t) = \left(1 - \left(\frac{e^{-\delta\omega_n t}}{\sqrt{1-\delta^2}}\right)\sin(\omega_d t + \theta)\right)$$



INTRODUCTION

- The various time domain specifications are:

1. Delay time
2. Rise Time
3. Peak Time
4. Peak Overshoot
5. Settling Time
6. Steady State Errors

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1. Delay time:

It is the time required for the response to reach half of its final value from the zero instant. It is denoted by t_d.

$$t_d = \frac{1 + 0.7\delta}{\omega_n}$$

2. Rise time (tr):

It is the time required for the response to rise from 0% to 100% of its final value.

$$t_r = \frac{\pi - \theta}{\omega_d}$$

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3. Peak time (tp):

It is the time required for the response to reach the peak value for the first time. It is denoted by tp. At t=tp, the first derivate of the response is zero.

$$t_p = \frac{\pi}{\omega_d}$$

4. Peak Overshoot (Mp):

Peak overshoot Mp is defined as the deviation of the response at peak time from the final value of response. It is also called the maximum overshoot.

$$\%M_p = \frac{c(t_p) - c(\infty)}{c(\infty)} \, x \, 100 \qquad \%M_p = \left(e^{-\left(\frac{\delta\pi}{\sqrt{1-\delta^2}}\right)} \right) \times 100\%$$

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5. Settling Time (ts):

It is the time required for the response to reach the steady state and stay within the specified tolerance bands around the final value. In general, the tolerance bands are 2% and 5%.

$$t_s = \frac{3}{\delta\omega_n} = 3\tau$$

$$t_s = \frac{4}{\delta\omega_n} = 4\tau$$