

### *Unit 3: Dynamic Response and Transient Analysis*

#### **3.3 Time Domain Specifications of a Step Response**

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For the step response of a system, there are four parameters which are very important in designing the control system.

- Rise time ( $t_r$ )
- Settling time ( $t_s$ )
- Overshoot ( $M_p$ )
- Peak time ( $t_p$ )

##### **Rise time ( $t_r$ )**

The rise time is the time it takes the system to reach the vicinity of the new set point. The rise time of a second order system can be approximated as follows.

Even for higher order systems, expression for  $t_r$  can be used as a rough approximation.

##### **Settling time ( $t_s$ )**

Settling time is the time it takes the system transients to decay.

### **Overshoot ( $M_p$ )**

The overshoot is the maximum amount the system overshoots its final value divided by its final value.

By differentiating  $y(t)$ , w.r.t  $t$  and equating to zero, an expression for  $M_p$  can be derived.

### **Peak time ( $t_p$ )**

Peak time is the time taken by the system to reach the maximum point.

### **Example-1**

Find the allowable region for the poles of the system if the system step response requirements are as follows

$$t_r \leq 0.6 \text{ s}, t_s \leq 3 \text{ and } M_p \leq 10\%$$