

a

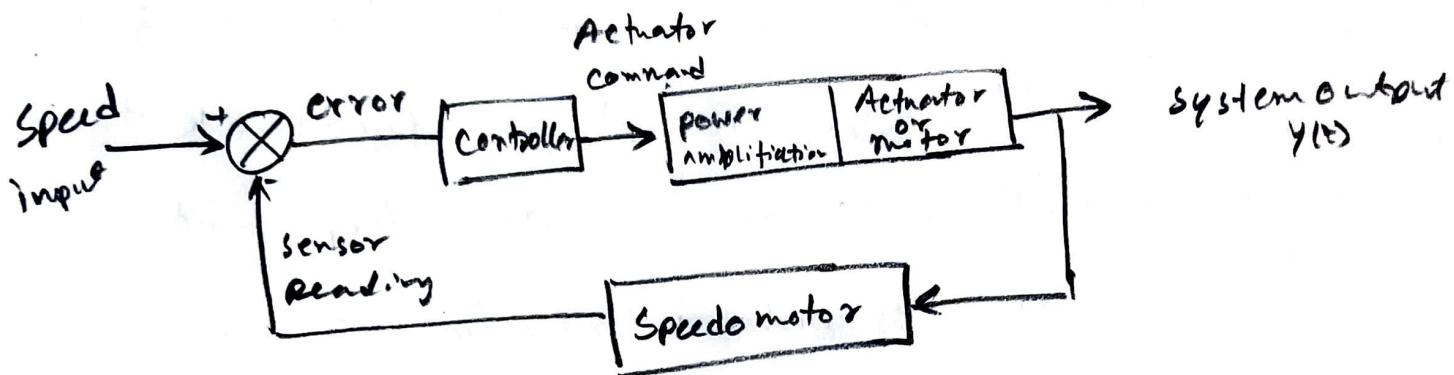
Open-loop control system is a type of control system that's output is not get feedback to the controller. Whereas in close-loop control system, the output information returns back to the controller as a feedback, based on this information controller can observe if it got desired output or not.

As, in this scenario, the car's motion or speed is need to observe and based on current speed adjusts the throttle to maintain desired speed. So here close-loop control system is required. Main reasons are:

- i. A feedback information is send to controller.
- ii. Based on output, the speed adjusts the throttle to maintain desired speed.
- iii. The controller needs the speed update.

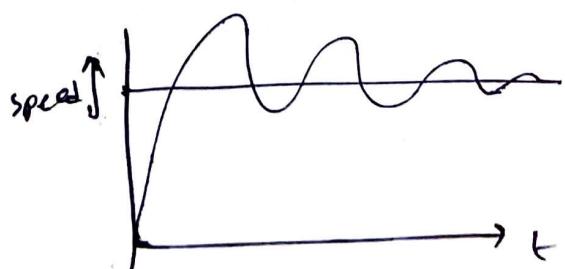
b.

close-loop :



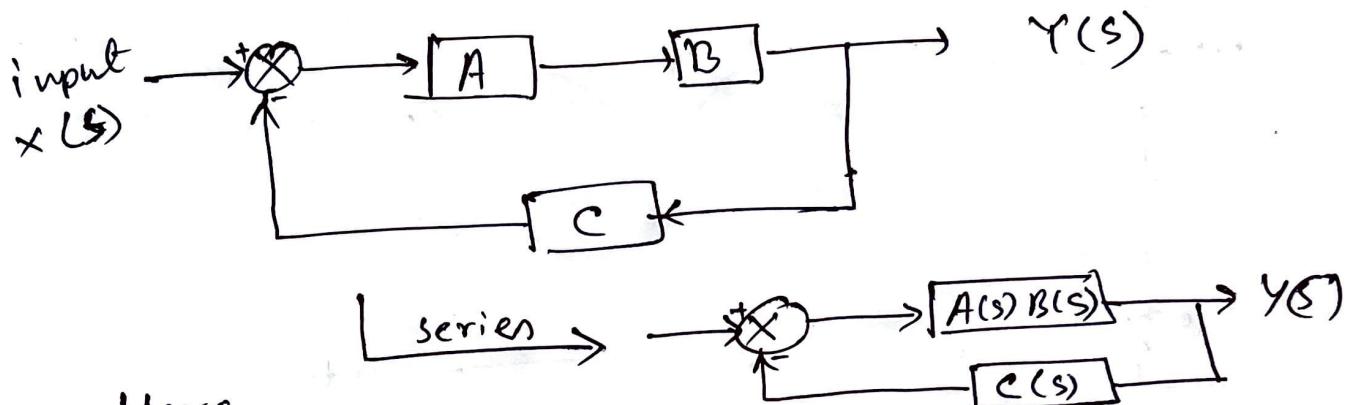
Here, 60 mph will be the input speed and the controller sends the electric signal which gets amplified and sends to actuator. Here actuator is motor. It acts accordingly and output is send. By using speedometer this output goes as a feedback to the error to distinguish the desired value.

The curve



C.

Denoting the 'B' diagram with
Symbolic Alphabets.



Here,

The transfer function is,

$$\frac{A(s) * B(s)}{1 + A(s) * B(s) * C(s)} * X(s)$$

As, A and B in series, so,

$$[A] - [B] = \boxed{[A(s) * B(s)]}$$

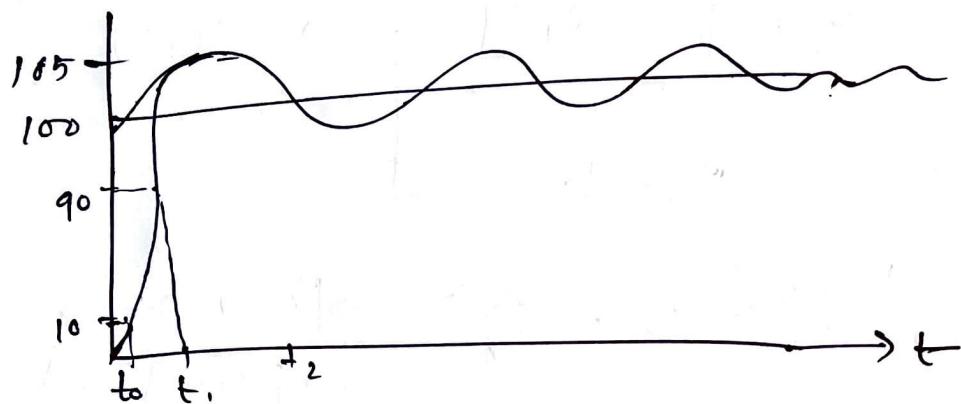
$A(s) * B(s)$ and $C(s)$ in parallel.

So, the function will be,

$$x(s) \rightarrow \boxed{\frac{A(s) * B(s)}{1 + A(s) * B(s) * C(s)}} \rightarrow Y(s)$$

d.

In feedback system we expect diagram as,



Overshoot: It is the percentage of the required value of first oscillation. At the peak of the first amplitude. Here we can see it is up to 105 of 100 required value. so it's $\frac{105-100}{100} \Rightarrow 5\%$.

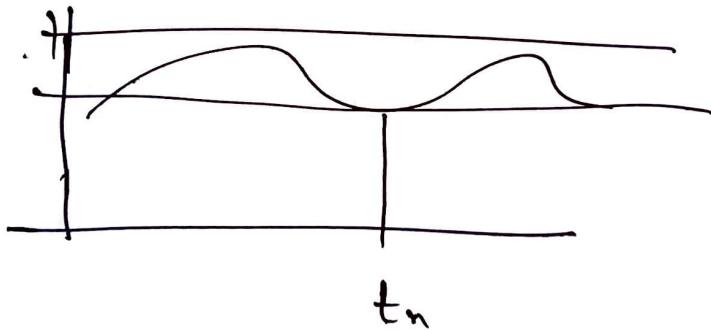
It gives a ratio how upward it went at first time.

Rise time: It is the time interval between the curve's 10% to 90% movement. It gives us a rapid increase change time. Here, 100's 10% = 10 = t_0
100's 90% = 90 = t_1 ,

$$\therefore \text{Rise time} = t_0 - t_1$$

Settling Time :

It takes about to settle the curve or system within a specific tolerance band around. After which we can consider the curve is settle down. Usually it is specified at ~~6±5%~~ 2% to 5% of final steady - state value.



the settling time is at the peak that touch the curve.