SNS COLLEGE OF TECHNOLOGY

(AN AUTONOMOUS INSTITUTION)

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Department of Biomedical Engineering

Course Name: Control Systems

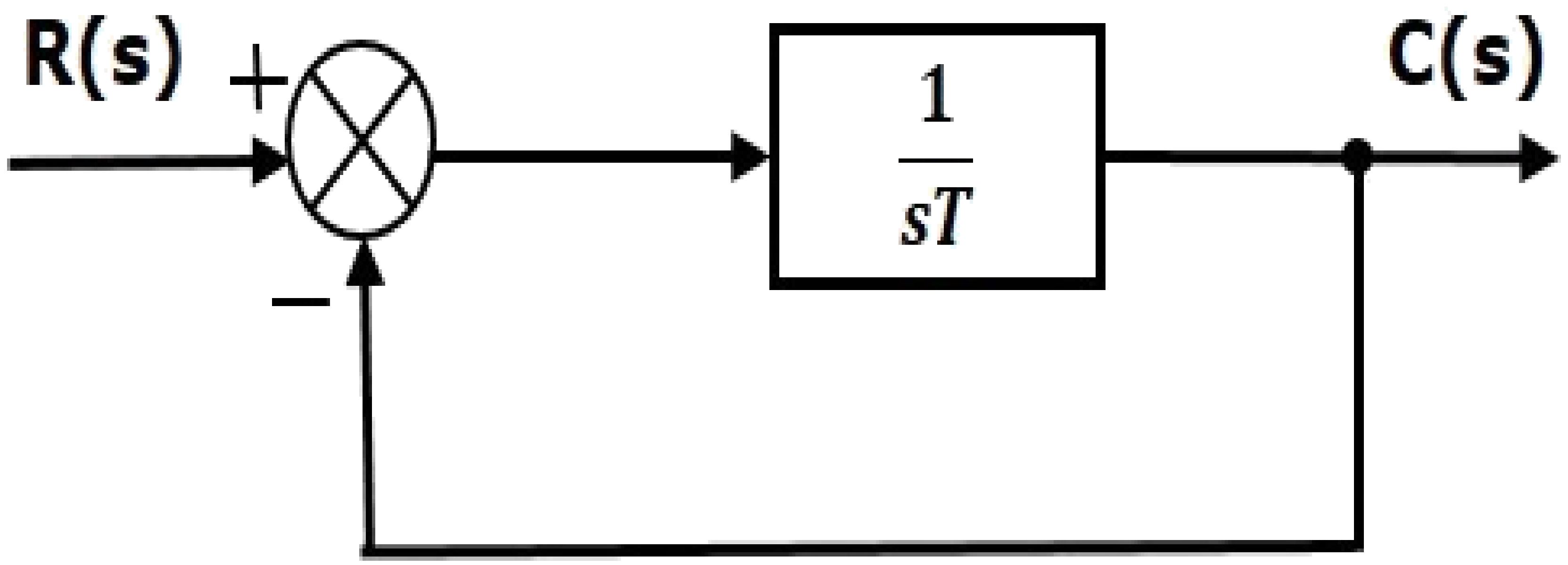
III Year : V Semester

Unit II –Time Response

Topic : First Order System

Introduction

- Consider the following block diagram of the closed loop control system.
- Here, an open loop transfer function, 1/sT is connected with a unity negative feedback. The system is called as first order system



First Order Response

- The closed loop transfer function of the system is given by

$$\frac{C(s)}{R(s)} = \frac{G(s)}{1+G(s)}$$

- Substituting the transfer function for first order system in above equation

$$\frac{C(s)}{R(s)} = \frac{\frac{1}{sT}}{1+\frac{1}{sT}} = \frac{1}{sT+1}$$

$$R(s) = \frac{1}{s}$$

First Order Response

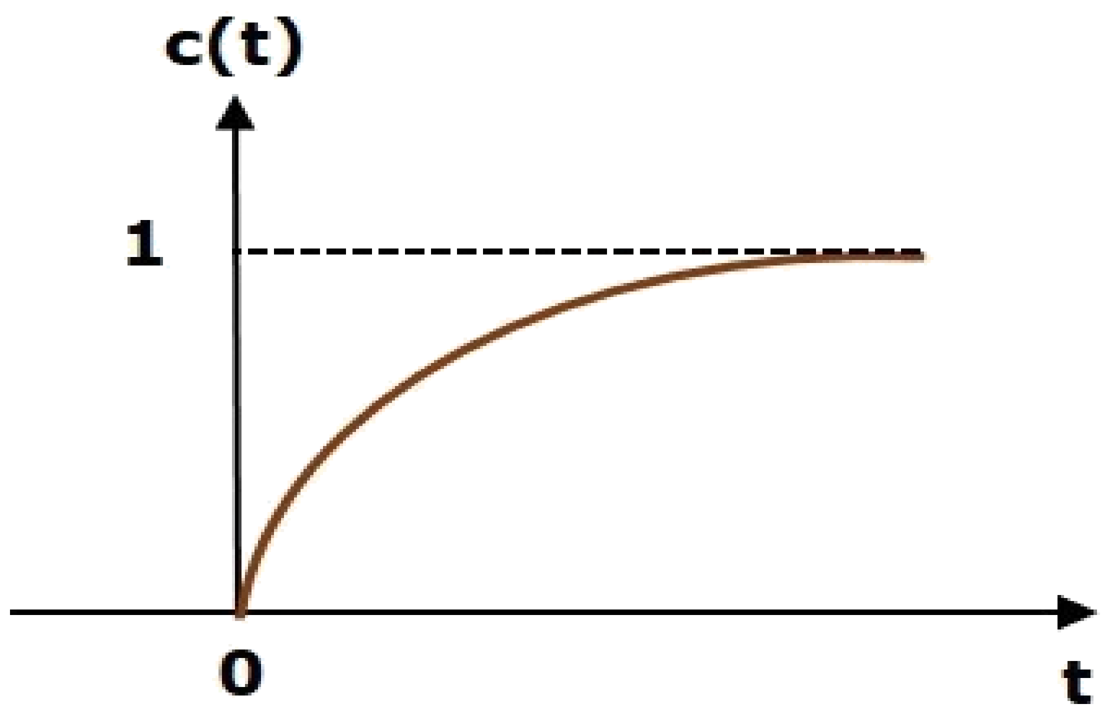
$$C(s) = \left(\frac{1}{sT+1}\right)\left(\frac{1}{s}\right) = \frac{1}{s\,(sT+1)}$$

$$C(s) = \frac{1}{s\,(sT+1)} = \frac{A}{s} + \frac{B}{sT+1}$$

$$C(s) = \frac{1}{s} - \frac{T}{sT+1} = \frac{1}{s} - \frac{T}{T\left(s+\frac{1}{T}\right)}$$

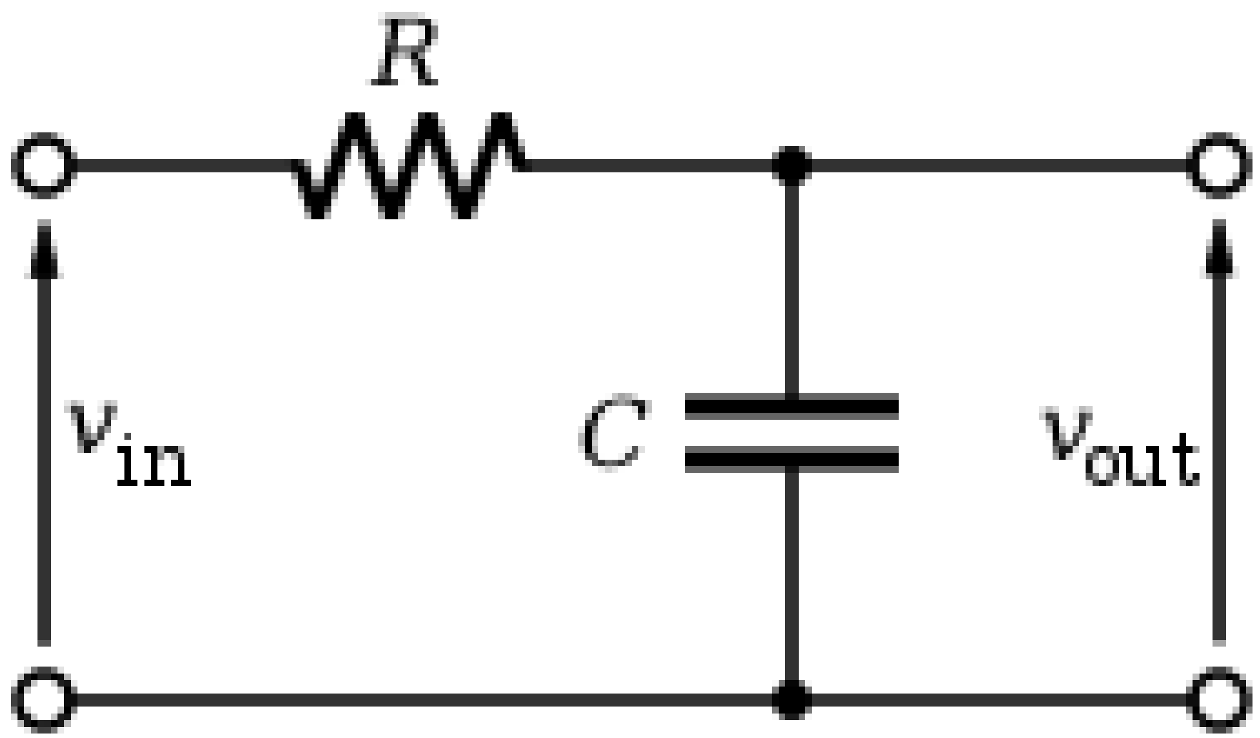
Applying Laplace inverse transform

$$c(t) = \left(1 - e^{-\left(\frac{t}{T}\right)}\right)$$



Practical Example

A first-order RC filter:



$$\frac{dV_{out}}{dt} = \frac{1}{RC}(V_{in} - V_{out})$$

$$\frac{V_{OUT}}{V_{IN}} = \frac{1}{1 + sRC}$$