SNS COLLEGE OF TECHNOLOGY

Coimbatore-13
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECT212 – CONTROL SYSTEMS

II YEAR/ IV SEMESTER

UNIT 2 – TIME RESPONSE ANALYSIS

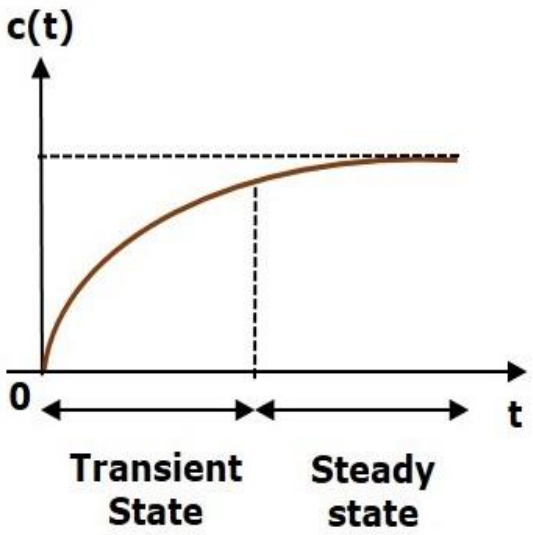
TOPIC 1- TIME RESPONSE ANALYSIS

OUTLINE

- REVIEW ABOUT PREVIOUS CLASS
- WHAT IS TIME RESPONSE?
- TRANSIENT RESPONSE
- STEADY STATE RESPONSE
- ACTIVITY
- STANDARD TEST SIGNALS
  - UNIT IMPULSE SIGNAL
  - UNIT STEP SIGNAL
  - UNIT RAMP SIGNAL
  - UNIT PARABOLIC SIGNAL
- SUMMARY

WHAT IS TIME RESPONSE?

- If the output of control system for an input varies with respect to time, then it is called the time response of the control system. The time response consists of two parts.
  - Transient response
  - Steady state response



WHAT IS TIME RESPONSE?

The responses corresponding to these states are known as transient and steady state responses.

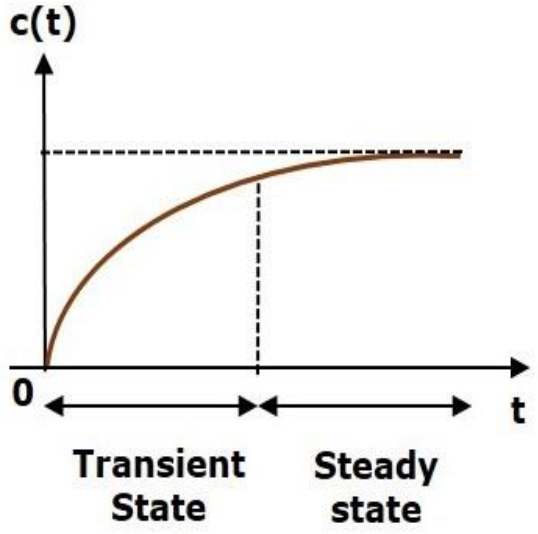
Mathematically, we can write the time response c(t) as

$$c(t)=c_{tr}(t)+c_{ss}(t)$$

Where,

$c_{tr}(t)$ is the transient response

$c_{ss}(t)$ is the steady state response



TRANSIENT RESPONSE

input → control system, output → certain time to reach steady state.

output → in transient state till it goes to a steady state.

Therefore, the response of the control system during the transient state is known as **transient response**.

The transient response will be zero for large values of 't'.

Ideally, this value of 't' is infinity

practically, it is five times constant.

Mathematically, we can write it as $\lim_{t\to\infty} c_{tr}(t) = 0$

STEADY STATE RESPONSE

The part of the time response that remains even after the transient response has zero value for large values of 't' is known as **steady state response.**

This means, the transient response will be zero even during the steady state.

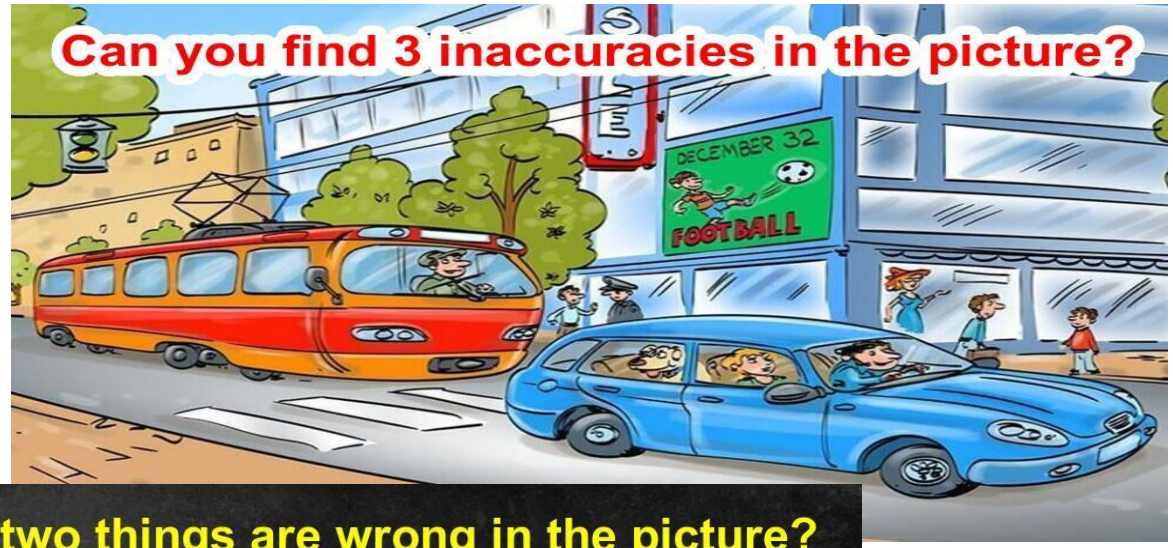
Example

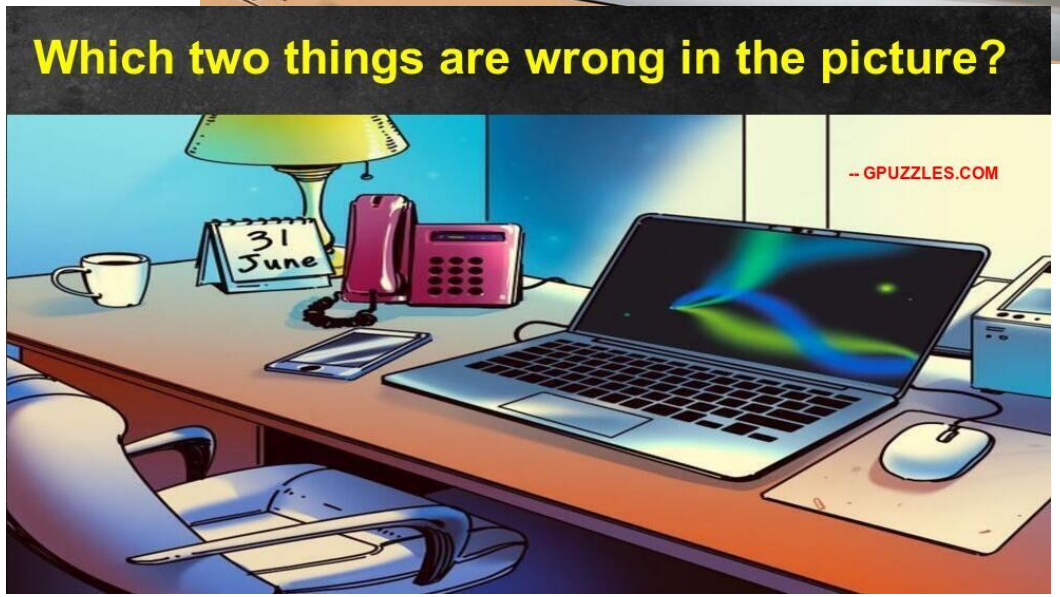
Let us find the transient and steady state terms of the time response of the control system $c(t)=10+5\ e-t$

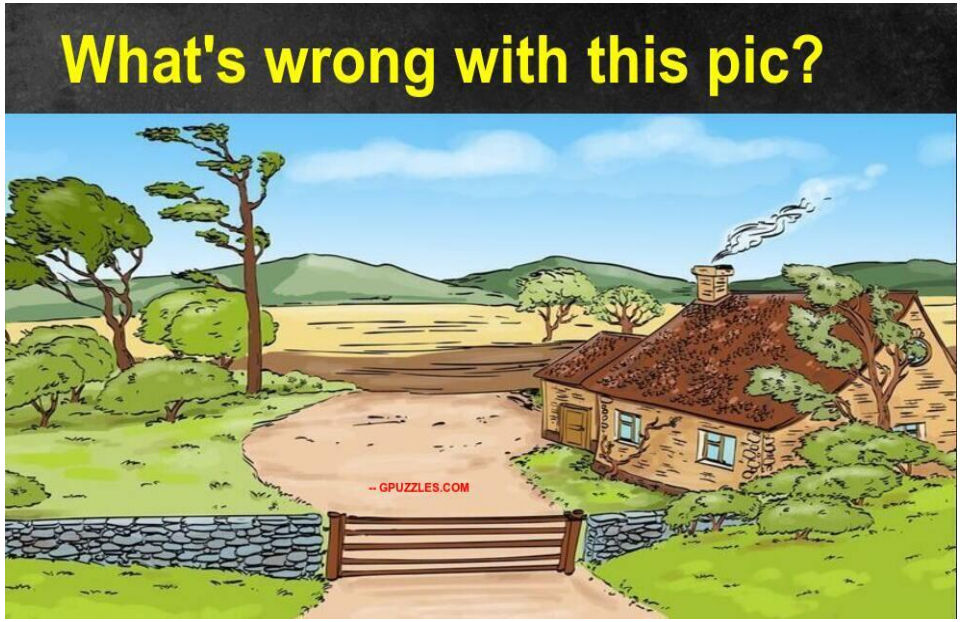
Here, the second term 5e–t will be zero as **t** denotes infinity. So, this is the **transient term.**

first term 10 remains even as **t** approaches infinity. So, this is the **steady state term.**

ACTIVITY -PICTURE BRAIN TEASERS







STANDARD TEST SIGNALS

The standard test signals are impulse, step, ramp and parabolic.

To know the performance of the control systems using time response of the output.

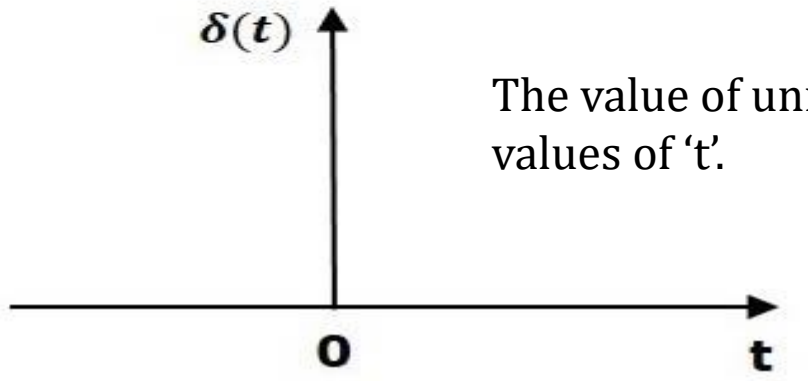
1.Unit Impulse Signal

A unit impulse signal, δ(t) is defined as

$$\delta(t) = 0 \quad \text{for} \quad t \neq 0$$

and $\int_{0^-}^{0^+} \delta(t)dt = 1$

The following figure shows unit impulse signal.



It exists only at 't' =0. The area of this signal under small interval of time around 't' is equal to zero is one.

The value of unit impulse signal is zero for all other values of 't'.

STANDARD TEST SIGNALS

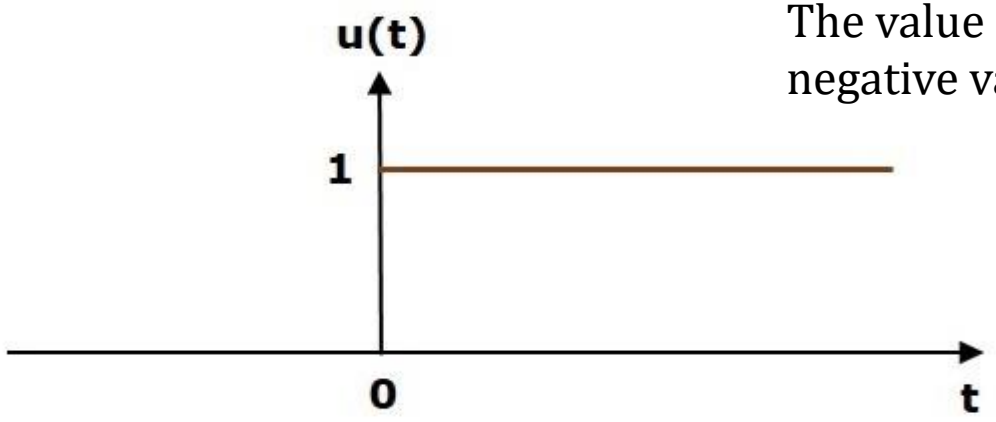
2.Unit Step Signal:

A unit step signal, u(t) is defined as

$$r(t) = Au(t)$$

$$u(t) = 1; t \geq 0$$

$$= 0; t < 0$$



It exists for all positive values of 't' including zero. its value is one during this interval.

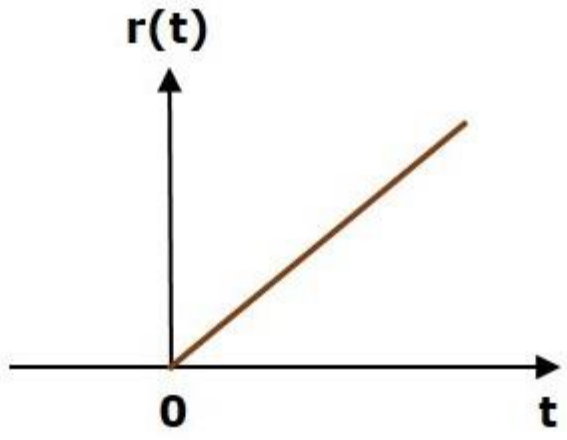
The value of the unit step signal is zero for all negative values of 't'.

STANDARD TEST SIGNALS

3. Unit Ramp Signal:

Ramp signal is a signal which starts at a value of zero and increases linearly with time.

$$r(t) = At; t \geq 0$$
$$= 0; t < 0$$



It exists for all positive values of ‘t’ including zero. its value increases linearly with respect to ‘t’ during this interval.

The value of unit ramp signal is zero for all negative values of ‘t’.

STANDARD TEST SIGNALS

4. Unit Parabolic Signal

A unit parabolic signal, p(t) is defined as,

$$p(t) = \frac{t^2}{2}; t \geq 0$$

$$= 0; t < 0$$

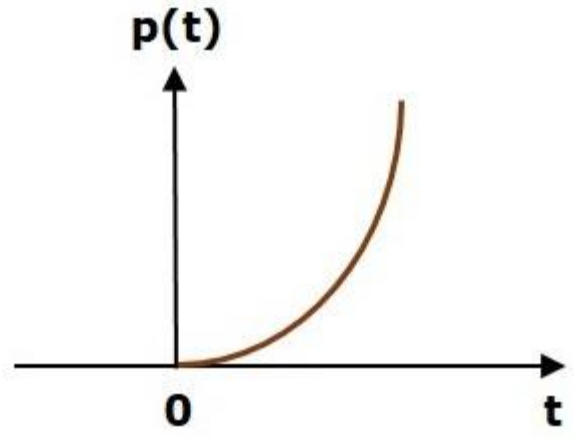
We can write unit parabolic signal, $p(t)$ in terms of the unit step signal, $u(t)$ as,

$$p(t) = \frac{t^2}{2} u(t)$$

4. UNIT PARABOLIC SIGNAL...

The instantaneous value varies as square of the time from an initial value of zero at time t=0.

$$r(t) = \frac{At^2}{2}; t \geq 0$$
$$= 0; t < 0$$



It exists for all the positive values of **'t'** including zero.

its value increases non-linearly with respect to 't' during this interval.

The value of the unit parabolic signal is zero for all the negative values of 't'.

SUMMARY