Standard Test Signals

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1 Introduction

The performance of a control system can be judged based on its response to a few common inputs such as a sudden shock, a sudden change in its state, an input that linearly increases with time, and an input that increases quadratically. These are called the standard test signals.

In signals perspective, these are an impulse, a step, a ramp, and a parabolic signal. Also a sinusoidal signal.

Sine wave signal is used for frequency domain analysis where except sine wave, all are used for time domain analysis.

2 The Step Signal

- A signal that abruptly changes from one constant value to another at a specific time, typically from 0 to a constant value.
- The unit step signal which is denoted by $u(t)$ and is defined as

$$\begin{aligned} u(t) &= 0 \qquad \text{for } -\infty < t < 0, \\ u(t) &= 1 \qquad \text{for } 0 \leq t < \infty. \end{aligned}$$

- The Laplace transform of the step signal is $U(s) = \frac{1}{s}$.

3 The Ramp Signal

- A ramp signal starts from the origin and rises linearly with time and a slope.
- Let $r(t)$ be the ramp signal, then

$$\begin{aligned} r(t) &= 0 \qquad \text{for } t < 0, \\ r(t) &= kt \qquad \text{for } t \geq 0. \end{aligned}$$

  where k is the slope
- The Laplace transform of the ramp signal is $R(s) = \frac{k}{s^2}$.

4 The Parabolic Signal

- The parabolic signal starts from zero and is a quadratic function of time.
- Let $p(t)$ be the parabolic signal, then

$$p(t) = 0 \qquad \text{for } t < 0,$$
$$p(t) = \frac{kt^2}{2} \qquad \text{for } t \geq 0.$$

  where k is the slope
- The Laplace transform of the parabolic signal is $P(s) = \frac{k}{s^3}$.

5 The Impulse Signal

- The impulse signal represents a sudden shock to the system.
- A signal that is zero everywhere except at a single point where it has an infinite value with an area of 1.

$$\begin{aligned} \delta(t) &= 0 && \text{for } t \neq 0, \\ \delta(t) &= \infty && \text{for } t = 0. \end{aligned}$$

  And the area $\int_{-\infty}^{\infty} \delta(t)\, dt = 1$.

- The Laplace transform of the impulse signal is $\Delta(s) = 1$.