Mathematical Representation of Signals

Basic operations on Signals:

There are two variable parameters in general:

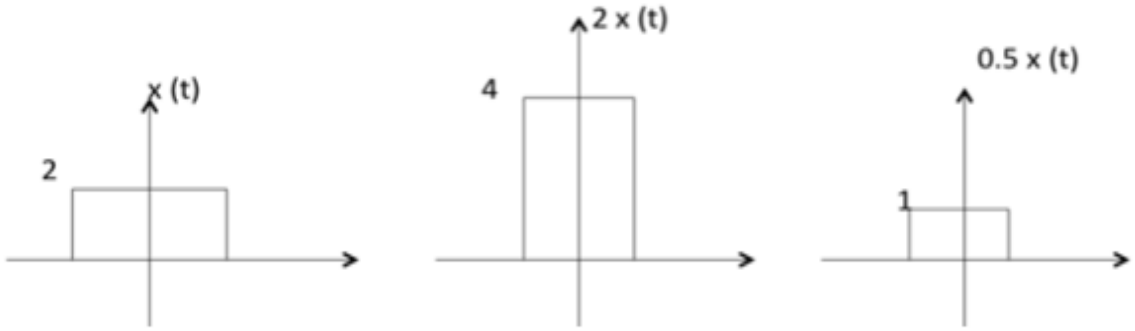
1. Amplitude

2. Time

(1) The following operation can be performed with amplitude:

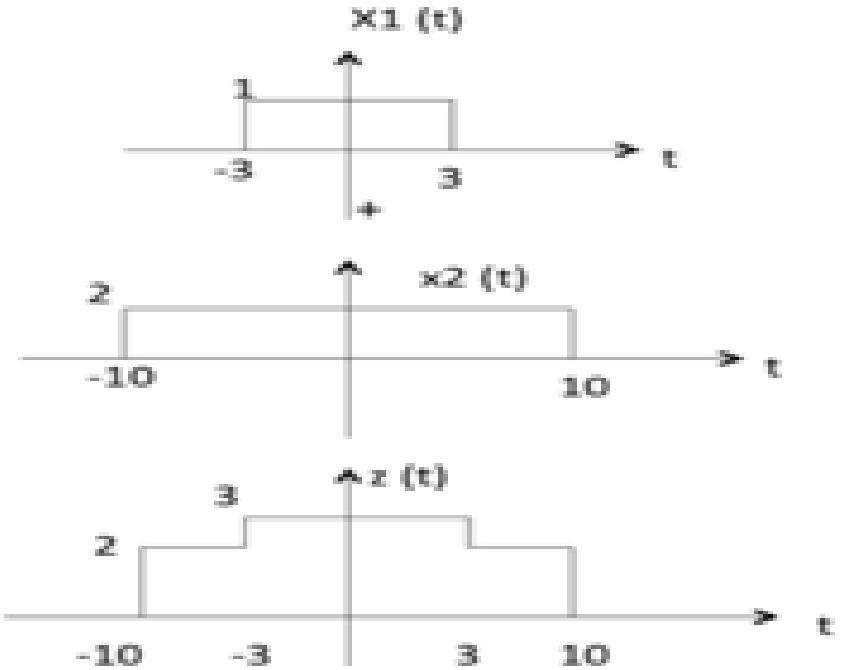
Amplitude Scaling

C x(t) is a amplitude scaled version of x(t) whose amplitude is scaled by a factor C.



Addition

Addition of two signals is nothing but addition of their corresponding amplitudes. This can be best explained by using the following example:



As seen from the previous diagram,

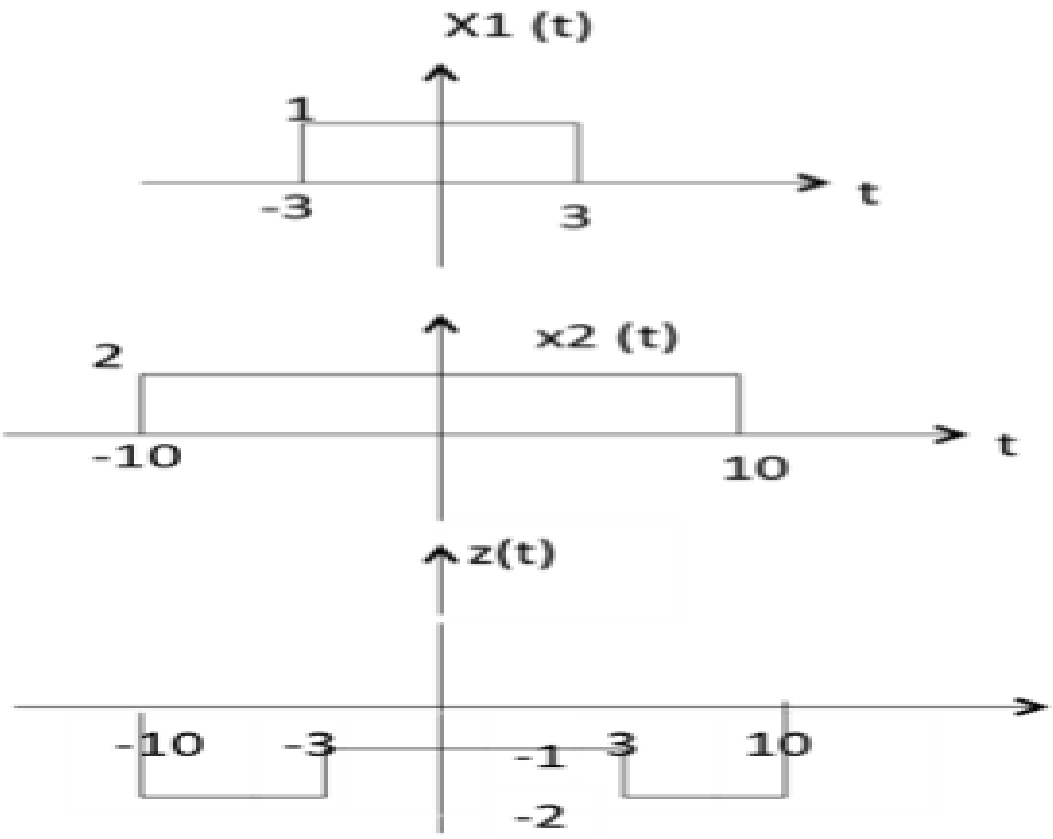
$-10 < t < -3$ amplitude of $z(t) = x1(t) + x2(t) = 0 + 2 = 2$

$-3 < t < 3$ amplitude of $z(t) = x1(t) + x2(t) = 1 + 2 = 3$

$3 < t < 10$ amplitude of $z(t) = x1(t) + x2(t) = 0 + 2 = 2$

Subtraction

Subtraction of two signals is nothing but subtraction of their corresponding amplitudes. This can be best explained by the following example:



As seen from the diagram above,

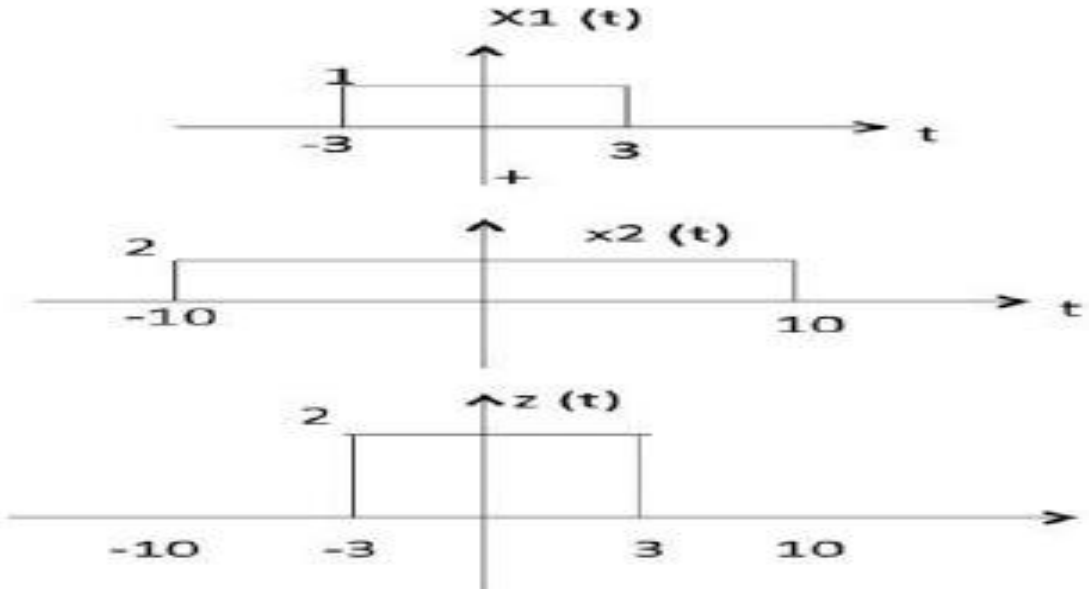
$-10 < t < -3$ amplitude of $z(t) = x1(t) - x2(t) = 0 - 2 = -2$

$-3 < t < 3$ amplitude of $z(t) = x1(t) - x2(t) = 1 - 2 = -1$

$3 < t < 10$ amplitude of $z(t) = x1(t) - x2(t) = 0 - 2 = -2$

Multiplication

Multiplication of two signals is nothing but multiplication of their corresponding amplitudes. This can be best explained by the following example:



As seen from the diagram above,

$-10 < t < -3$ amplitude of $z(t) = x1(t) \times x2(t) = 0 \times 2 = 0$

$-3 < t < 3$ amplitude of $z(t) = x1(t) - x2(t) = 1 \times 2 = 2$

$3 < t < 10$ amplitude of $z(t) = x1(t) - x2(t) = 0 \times 2 = 0$

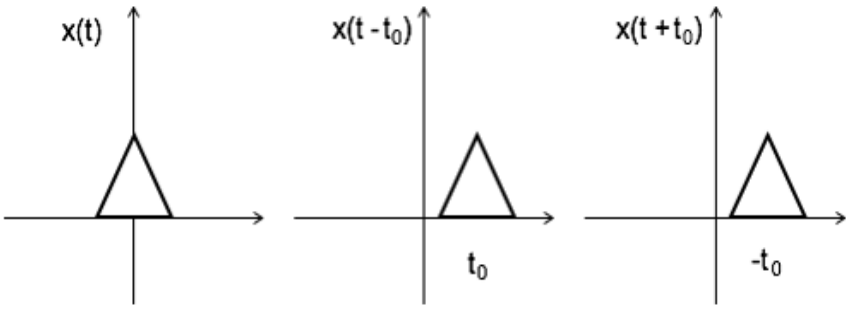
(2) The following operations can be performed withtime:

Time Shifting

$x(t \pm t0)$ is time shifted version of the signal $x(t)$.

$x(t + t0) \rightarrow$negative shift

$x(t - t0) \rightarrow$positive shift

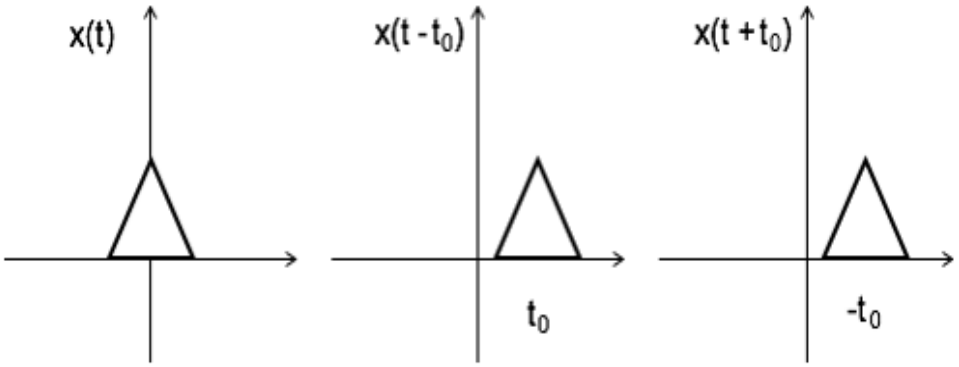


Time Scaling

x(At) is time scaled version of the signal x(t). where A is always positive.

|A| > 1 → Compression of the signal

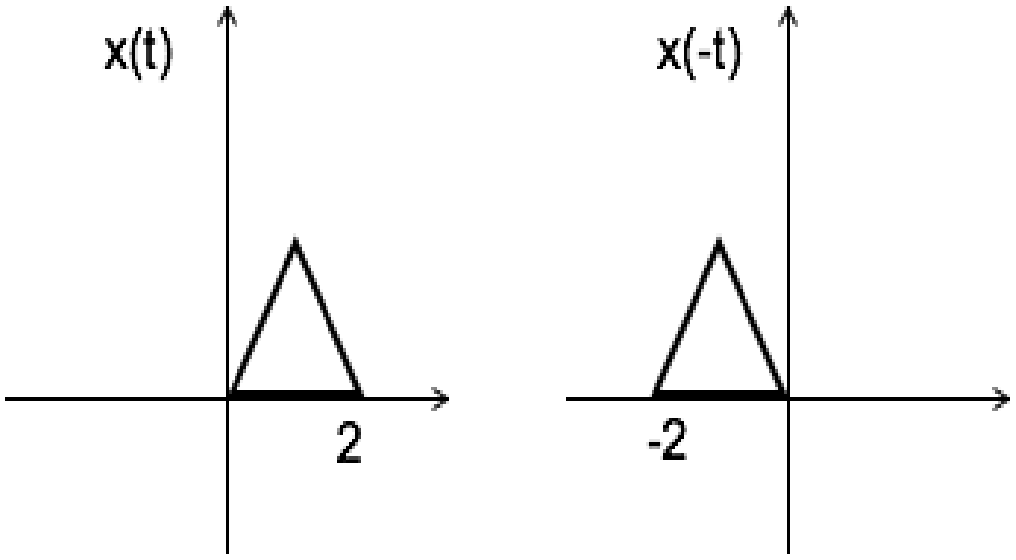
|A| < 1 → Expansion of the signal



Note: u(at) = u(t) time scaling is not applicable for unit step function.

Time Reversal

x(-t) is the time reversal of the signal x(t).


x(t)
2
x(-t)
-2