**Time Shifted Signals**

- Given a continuous-time signal \( x(t) \) and a positive real number \( t \), the signal \( x(t-t) \) is \( x(t) \) shifted to the right by \( t \) seconds and the signal \( x(t+t) \) is \( x(t) \) shifted to the left by \( t \) secs. For example:

\[
\begin{align*}
\text{U}(t-2) & \quad \text{U}(t+2) \\
0 & \quad 2 & \quad -2 & \quad 0 & \quad 2 & \quad 4 \\
1 & \quad 1 & \quad 0 & \quad 2 & \quad 4 \\
\end{align*}
\]

**Continuous and Piecewise-Continuous Signals**

- A continuous-time signal \( x(t) \) is said to be **discontinuous** at a fixed point \( t \), if

\[
x(t^-) \neq x(t^+) \]

i.e., a signal \( x(t) \) is discontinuous at a point \( t \), if the value of \( x(t) \) "jumps" as \( t \) goes through the point \( t \). For example, the unit step function \( u(t) \) is discontinuous at \( t = 0 \) as shown in the figure below:

\[
x(t) = u(t) \\
x(0^-) = 0 \\
x(0^+) = 1
\]
- A signal \( x(t) \) is continuous at the point \( t \) if
\[
x(t_1^-) = x(t) = x(t_1+)
\]
- If a signal \( x(t) \) is continuous at all points of \( t \), the \( x(t) \) is said to be a continuous signal.

For example, a ramp function, the sinusoids and the triangular function are continuous functions.

**Note**: The term continuous is used in two different ways, i.e., there is the notion of a continuous-time signal and there is the notion of a continuous-time signal that is continuous.

**Representation of Piecewise-Continuous Signals**

**Example 1**:

\[
x(t) = \begin{cases} 
2t+1, & 0 \leq t < 1 \\
1, & 1 \leq t \leq 2 \\
-t+3, & 2 \leq t \leq 3 \\
0, & t > 3 
\end{cases}
\]

\[
x(t) = (2t+1) [u(t) - u(t-1)] + 1 [u(t-1) - u(t-2)] + (-t+3) [u(t-2) - u(t-3)]
\]

\[
= (2t+1)u(t) - (2t+1)u(t-1) - (1 + t-3)u(t-2) + (t-3)u(t-3)
\]

\[
= (2t+1)u(t) - 2t u(t-1) - (t-2)u(t-2) + (t-3)u(t-3)
\]

**Example 2**:

\[
x(t) = \begin{cases} 
1, & 0 \leq t \leq 2 \\
0, & t > 0
\end{cases}
\]

\[
x(t) = 1[u(t) - u(t-2)]
\]

\[
x(t) = u(t) - u(t-2)
\]