General Response of a Linear System

Let the input to the system be $x(t)$ and let the output or response be $y(t)$. For a linear system, these are related by

$$y(t) = \int_{\xi=-\infty}^{0} x(t + \xi)\, W(\xi)\, d\xi \tag{1}$$

where $W(\xi)$ is called the "system weighting function." Note that we allow ξ only to be negative, and disallow any influence of the future on the present. This equation says that potentially, inputs from **all** previous times (times less than t, the moment at which we are looking at the output $y(t)$) may influence the present output, by an amount which is "weighted" by this system weighting function $W(\xi)$.

For first-order systems like a thermocouple, the weighting function is

$$W(\xi) = \frac{1}{\tau}\, e^{\frac{\xi}{\tau}} \tag{2}$$

where τ is the time constant of the device. Since we have defined ξ as negative, the weighting function gets smaller for inputs that occurred further in the past... input from very long ago is forgotten.