1. Let $x(t) = A \cos \omega t$ where A is a positive real constant. Find

a. the signal energy over one period

b. the average power of the signal

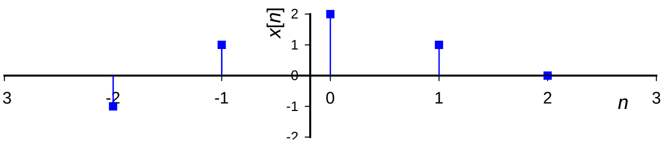
2. Determine if each of the following systems are memoryless, causal, stable, and time-invariant :

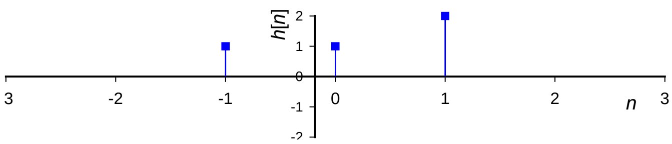
a. $y(t) = x(t-6)$

b. $y(t) = dx/dt$

c. $y(t) = \int_{-\infty}^{t/3} x(s)\,ds$

3. Find $y[n] = x[n] * h[n]$ for the signals shown below





4. Compute the autocorrelation function for $x(t) = e^{-at}u(t)$. Assume that $\tau > 0$. Find the energy content of the above signal by considering the energy spectral density.

(Note that $FT\left[e^{-a\tau}u(\tau)\right] = \dfrac{1}{a + j\omega}$ and $\int \dfrac{1}{1+x^2}dx = \arctan x$)

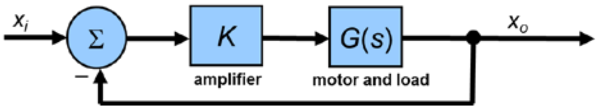
5. Find the discrete Fourier transform of the signal $x[n] = \{2, 0, -1, 3\}$

6. Consider the demodulation of a DSB signal $x(t) = m(t)\cos(\omega_c t)\cos(\omega_c t + \pi/2)$. What is the effect of the phase error on the output?

7. Describe the working of the *lock-in amplifier*, and explain how it can amplify very weak low frequency signals in the presence of typical background noise sources.

8.

A feedback motor control system may be represented by the block diagram shown on the right.



a) Explain how this system acts to make the output position x_o follow the requested input position x_i.

b) Show that the system transfer function $H(s) = KG(s)/\left[1 + KG(s)\right]$.

c) If $G(s) = 1/s(s+4)$ and $K = 3$, determine the time dependent output to a step function input $x_i = u(t)$.

d) Is the system under-damped or over-damped? For what value of K would it be critically damped?

NB $\dfrac{3}{s(s+3)(s+1)} = \dfrac{1}{s} - \dfrac{\frac{3}{2}}{(s+1)} + \dfrac{\frac{1}{2}}{(s+3)}$