Let $x(t)$ be a signal with Nyquist rate ω_0.
Determine the Nyquist rate for each of the following signals:

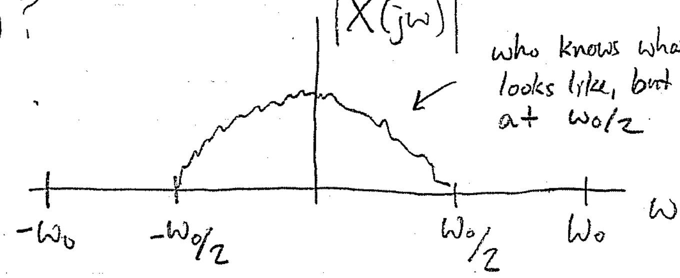
(a) $x(t) + x(t-1)$

(b) $\dfrac{d\,x(t)}{dt}$

(c) $x^2(t)$

(d) $x(t)\cos(\omega_0 t)$

The real question is: What do these operations do to the spectrum of $x(t)$?



who knows what this looks like, but it ends at $\omega_0/2$

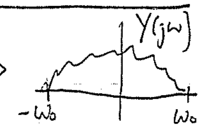
(a) If $y(t) = x(t) + x(t-1)$, then $Y(j\omega) = X(j\omega) + e^{-j\omega} X(j\omega)$

It is clear that $y(t)$ has the same bandwidth of $x(t)$, $\boxed{\omega_0}$

(b) If $y(t) = \frac{d}{dt} x(t)$, then $Y(j\omega) = \dfrac{X(j\omega)}{j\omega}$

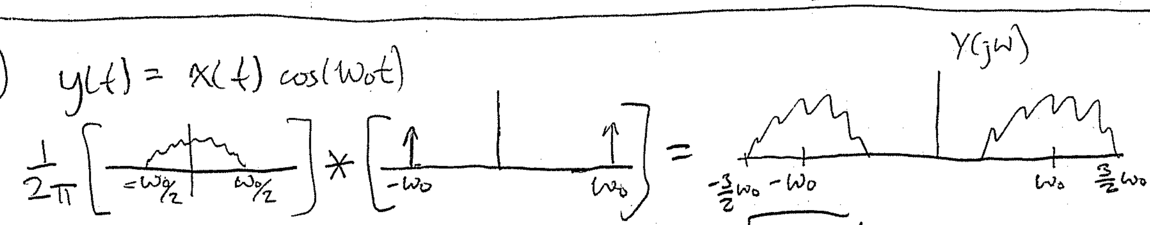
Since $X(j\omega)$ is zero for $|\omega| > \frac{\omega_0}{2}$, $Y(j\omega)$ is also, $\boxed{\omega_0}$

(c) If $y(t) = x(t)\,x(t)$, then $Y(j\omega) = \frac{1}{2\pi} X(j\omega) * X(j\omega) \rightarrow$



This will double the bandwidth of $x(t)$, $\boxed{2\omega_0}$

(d) $y(t) = x(t)\cos(\omega_0 t)$



This will triple the bandwidth, $\boxed{3\omega_0}$