Example: sinusoid at frequency $F_c = f_c F_s$ Hz.

$$x[n] \quad = \quad \cos(2\pi f_c n), \;\; n = 0, \ldots, N-1$$

$$X_{DTFT}(f) = \sum_{n=0}^{N-1} \cos\left(2\pi f_c n\right) e^{-2\pi f n} = \frac{1}{2} \sum_{n=0}^{N-1} \left(e^{j2\pi f_c n} + e^{-j2\pi f_c n}\right) e^{-j2\pi f n}$$

$$= \frac{1}{2} g_N(f - f_c) + \frac{1}{2} g_N(f + f_c)$$

$$g_N(\nu) = \sum_{n=0}^{N-1} e^{-j2\pi\nu n}$$

Use geometric series formula $\sum_{n=0}^{M} a^n = (1 - a^{M+1})/(1-a)$ to obtain

$$g_N(\nu) = N e^{-j\pi\nu(N-1)} \quad \underbrace{\frac{\sin(\pi\nu N)}{N\sin(\pi\nu)}}_{Dirichlet\ kernel}$$