# Ex06

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- Given an ideal low-pass filter friquency response

$$H(\omega) = \begin{cases} 1, & |\omega| < \omega_c \\ 0, & |\omega| > \omega_c \end{cases} \tag{0-1}$$

1. Find its impulse response $h[n]$

Hint:

1. use inverse Fourier transform definition to find $h[n]$
2. sinc function is defined i MATLAB as $\mathrm{sinc}(t) = \begin{cases} \frac{\mathrm{sinc}(\pi t)}{\pi t}, & t \neq 0 \\ 1, & t = 0 \end{cases}$

Answer:

$$h[n] = \frac{1}{2\pi}\int_{\infty}^{\infty} H(\omega) e^{j\omega n} d\omega \tag{0-2}$$

$$= \frac{1}{2\pi}\int_{-\omega_c}^{\omega_c} e^{j\omega n} d\omega \tag{0-3}$$

$$= \frac{1}{2\pi}\frac{1}{jn}(e^{j\omega_c n} - e^{-j\omega_c n}) \tag{0-4}$$

$$= \frac{1}{2\pi}\frac{1}{jn} 2j \sin(\omega_c n) \tag{0-5}$$

$$= \frac{1}{\pi n}\sin(\omega_c n) \tag{0-6}$$

$$= \frac{\omega_c}{\pi}\frac{\sin(\omega_c n)}{\omega_c n} \tag{0-7}$$

$$= \frac{\omega_c}{\pi}\mathrm{sinc}(\omega_c n) \tag{0-8}$$