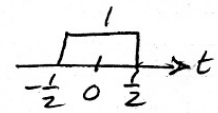
① Text, 12-5a, b, c, d

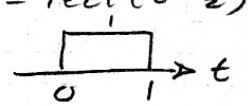
(a) $H(f) = \text{sinc}(f) \longleftrightarrow h(t) = \text{rect}(t)$



<u>NOT causal</u> - $h(t)$ is not 0 for $t < 0$

(b) $H(f) = \text{sinc}(f)\, e^{-j\pi f}$

$= \text{sinc}(f)\, e^{-j2\pi f(\frac{1}{2})} \longleftrightarrow h(t) = \text{rect}(t - \frac{1}{2})$



<u>causal</u>, since $h(t) = 0$ for $t < 0$

(c) $H(j\omega) = \text{rect}(\omega)$

or $H(f) = \text{rect}(2\pi f) \longleftrightarrow \frac{1}{2\pi}\,\text{sinc}\left(\frac{t}{2\pi}\right)$

<u>NOT causal</u>, since sinc is not 0 for $t < 0$

(d) $H(j\omega) = \text{rect}(\omega)\, e^{-j\omega}$

$= \text{rect}(2\pi f)\, e^{-j2\pi f} \longleftrightarrow \frac{1}{2\pi}\,\text{sinc}\left(\frac{t-1}{2\pi}\right)$

<u>Not causal</u>, since sinc is not 0 for $t < 0$

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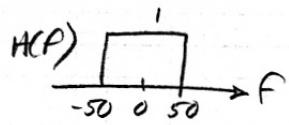
3 (a) $h(t) = 100\,\text{sinc}(100t) \longleftrightarrow \cancel{100}\,\frac{1}{\cancel{100}}\,\text{rect}\left(\frac{f}{100}\right) = \text{rect}\left(\frac{f}{100}\right)$

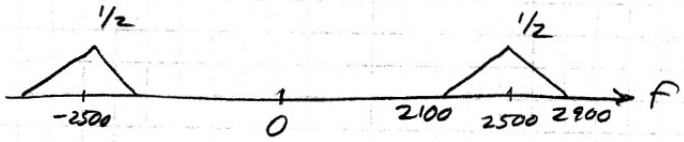


absolute BW = $\boxed{50\text{ Hz}}$ (50−0)

Null BW = $\boxed{50\text{ Hz}}$ (50−0)

−3dB BW = $\boxed{50\text{ Hz}}$ (50−0)

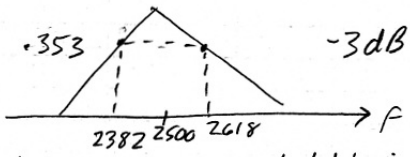
(b) H(f):



absolute BW = $\boxed{800\text{ Hz}}$ (2900−2100)

null BW = $\boxed{800\text{ Hz}}$ (2900−2100)

−3dB BW is determined by the frequencies corresponding to where $|H(f)|^2$ is down by 1/2 of its max value, or $|H(f)|$ is down by .707 of its max value, or $(1/2)(.707) = 0.353$.



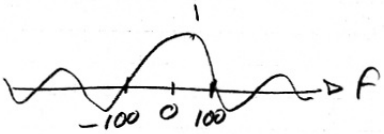
−3dB BW = 2618 − 2382 = $\boxed{236\text{ Hz}}$

* I used MATLAB to plot $\frac{1}{2}\text{tri}\left(\frac{f-2500}{400}\right)$, and zoomed in

(c) $h(t) = 100\,\text{rect}(100t) \longleftrightarrow H(f) = \cancel{100}\,\frac{1}{\cancel{100}}\,\text{sinc}\left(\frac{f}{100}\right)$

$= \text{sinc}\left(\frac{f}{100}\right)$

H(f):



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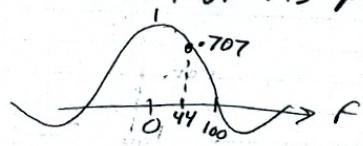
absolute BW = $\boxed{\infty}$

Null BW = $\boxed{100\,Hz}$ (100−0)

-3dB BW depends on the frequency where the $|H(f)|$ drops to 0.707 of its peak value.

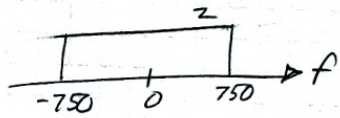


3dB BW = $\boxed{44\,Hz}$ (44−0)

* I used MATLAB to plot sinc $\left(\frac{f}{100}\right)$ and zoomed in.

(3) $H(f) = 2\,\mathrm{rect}\left(\frac{f}{1500}\right)e^{-j2\pi f\left(\frac{1}{500}\right)}$

$|H(f)|$



$\angle H(f)$

$x(t) = 2\cos(2\pi 225t + 0.25\pi) - 3\cos(2\pi 760t - 0.35\pi)$

For $y(t)$, the 760 Hz cosine does not get thru filter, since its cutoff freq is 750 Hz

$y(t) = |H(225)| \cdot 2\cos(2\pi 225t + 0.25\pi + \angle H(225))$

$= 2 \cdot 2 \cdot \cos(2\pi 225t + 0.25\pi + (-2\pi\, 225/500))$

$= 4\cos(2\pi 225t + .25\pi - 0.9\pi)$

$= \boxed{4\cos(2\pi 225t - 0.65\pi)}$

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