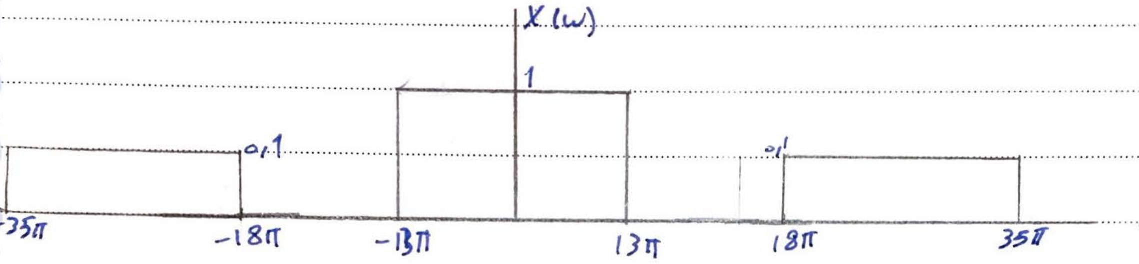
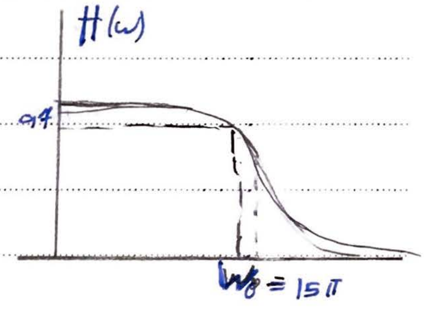
Haitham Babbili   / /

1) $H(w) = \dfrac{1}{1+j\frac{w}{w_0}}$; $w_0 = 15\pi \times 10^3$

$x(t) = x_s(t) + n(t)$





The noise is separeted from The usefull signal $x_s(t)$ and The noise value is outside The filter range.

where The Nyquist frequancy is

$w_s > 2 w_0$

Minimum sampling frequancy is

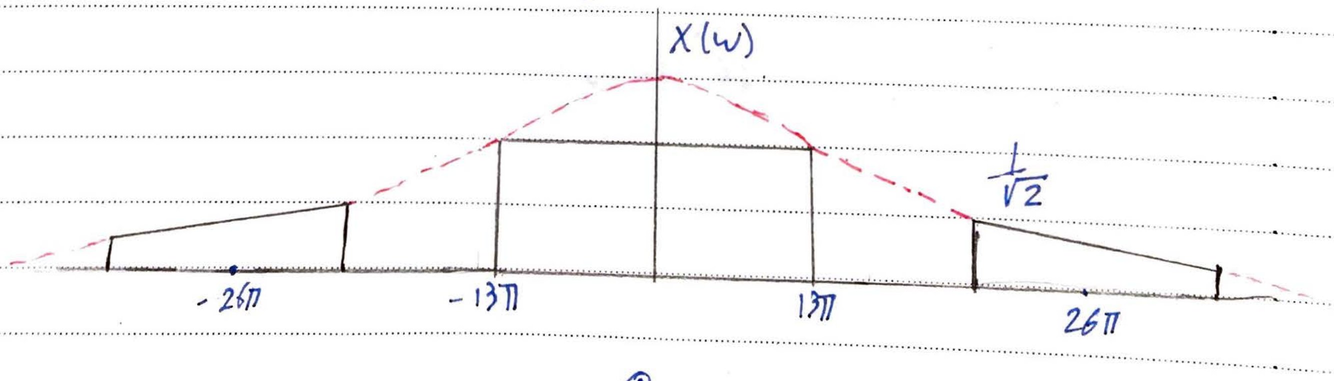
$w_s = 2 \times 15\pi \times 10^3 = 30\pi \times 10^3$ rad/s

So The minimum sampling rate $R_s = f_s = 30\pi \times 10^3$ rad/s

- $X(w) = X_s(w) + N(w)$

$Y(w) = H(w) \cdot X(w) = H(w) \cdot X_s(w) + H(w) \cdot N(w)$

$|H(w)| = \dfrac{1}{\sqrt{1+\left(\frac{w}{w_0}\right)^2}}$



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$\frac{1}{20}$ DTFT $[H(\omega)\, N(\omega)] <$ DTFT $[H(\omega)\, X_s(\omega)]$

The Nyquist here will be.

$W_s > 2W \quad ; W = 13\pi \times 10^3$

Sampling here well be $2 \times 13\pi \times 10^3 = 26\pi \times 10^3$ rad/s

$H(\omega)\, N(\omega) = \frac{1}{20}$;

$N(\omega) = 0.1$, $H(\omega) = \frac{1}{\sqrt{1+\left(\frac{W}{W_0}\right)^2}}$

$0.1 \cdot \frac{1}{\sqrt{1+\left(\frac{W}{W_0}\right)^2}} = \frac{1}{20} \Rightarrow \sqrt{1+\left(\frac{W}{W_0}\right)^2} = 2$

$1+\left(\frac{W}{W_0}\right)^2 = 4 \Rightarrow \left(\frac{W}{W_0}\right) = \sqrt{3}$

$W = \sqrt{3} \cdot W_0$;

$W \approx 26\pi \times 10^3$ rad/s

New W_s will be.

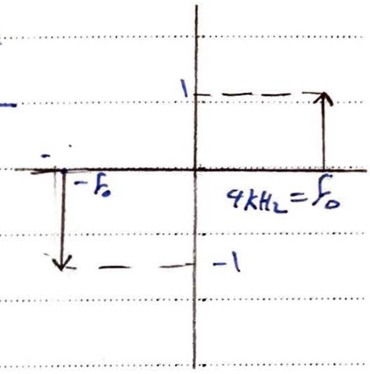
$W_s \geq 26\pi \times 10^3 - (-13\pi \times 10^{-3}$

$W_s \geq 39\pi \times 10^3$ rad/s

2

$$X_d(n) = \sin\left(2\pi n \frac{f_0}{f_s}\right) \quad ; \; f_0 = 4\,KHz$$
$$f_s = 15\,KHz$$

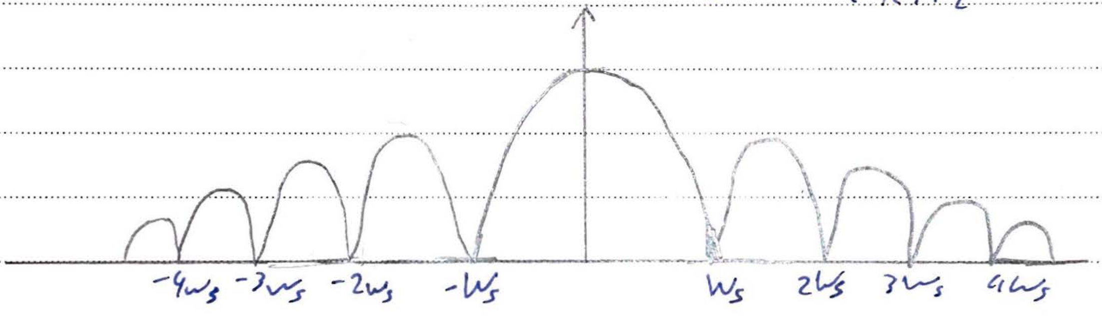
$$X(t) = \sin(2\pi f_0 t) = \frac{e^{j2\pi f_0 t} - e^{-j2\pi f_0 t}}{2j}$$



$$H_{ZOH}(w) = \Delta t \, e^{-j\pi \frac{w}{w_s}} \frac{\sin(\pi\, w/w_s)}{\pi \frac{w}{w_s}}$$

$$H_{ZOH}(0) = 1$$

number of Harmonics $= \dfrac{f_s}{f_0} = \dfrac{15\,KHz}{4\,KHz} = 3,75 \approx 4.$



at Δt, $|w| < \dfrac{w_s}{2}$

$$w_0 = 2\pi f_0 \Rightarrow 2\pi . 4\times10^3 = 8\pi\times10^3\,Hz$$

$\Rightarrow$ main frequancy $8\,KHz$.

$$H_{ZOH} = \Delta t \, e^{-j\pi \frac{4}{15}} \cdot \frac{\sin\left(\pi \frac{4}{15}\right)}{\pi \frac{4}{15}} =$$

Amplitud $= |H_{ZOH}(w)| . X_d(w)$

$$X_d(w) = \frac{\pi}{j}\left[\delta(w - w_0) - \delta(w + w_0)\right]$$

$$w = w_s = 15\,KHz \;,\; w_0 = 4\,KHz$$

/ /

$\therefore X(\omega) = \frac{\pi}{j}\left[\delta(11) - \delta(19)\right]$

$\therefore W = 2w_s = 30\,kHz \quad , W_0 = 4\,kHz.$

$X(\omega) = \frac{\pi}{j}\left[\delta(30-4) - \delta(30+4)\right]$

our harmonics at 11 kHz, 19 kHz, 26 kHz, 34 kHz.

$|Y(\omega)| = |H_{ZOH}(\omega)| \cdot X(\omega)$

$|Y(\omega)|_{w=w_0} = 2.7868$ main frequancy.

1st harmonic $|Y(\omega)|_{w=w_s-w_0} = 1.0134.$

2nd: harmonic $|Y(\omega)|_{w=w_s+w_0} = 0.5867$

3rd harmonic $|Y(\omega)|_{w=2w_s-w_0} = 0.4287$

4Th harmonic $|Y(\omega)|_{w=2w_s+w_0} = 0.3279.$