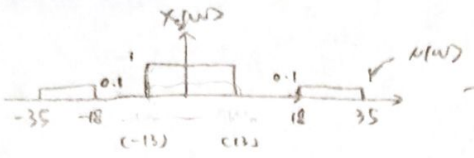
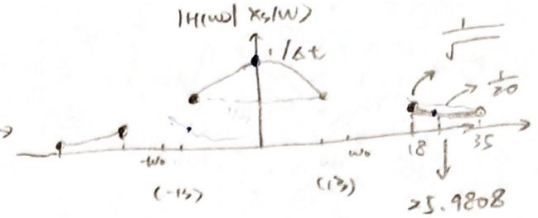
① ASP Handin-1

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

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

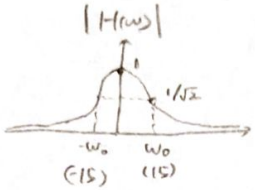




$x(t) \rightarrow$ [LP] $\rightarrow$ [sampling] $\rightarrow$

$H(w) = \frac{1}{1 + jw/w_0}$.

$|H(w)| = \frac{1}{|1 + jw/w_0|} = \frac{1}{\sqrt{1 + (w/w_0)^2}}$



sig: $\frac{1}{\sqrt{1+(13/15)^2}} \approx 1$

noise: $\left[\frac{1}{\sqrt{1+(35/15)^2}} \sim \frac{1}{\sqrt{1+(18/15)^2}}\right] \cdot 0.$

$= \left[\frac{1}{\sqrt{1+(7/3)^2}} \sim \frac{1}{\sqrt{1+(6/5)^2}}\right] \cdot 0.$

(a) $x_s \geq 2 W_0$ (15) $= 30\pi \times 10^3$ rad/s.

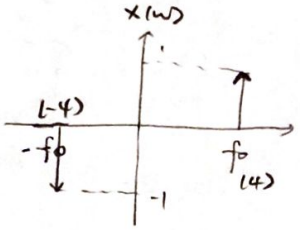
(b) $|H(w)|\ N(w) \cdot X_d(w) < \frac{1}{20} \cdot \frac{1}{\Delta t}$ for $|w| < 15\pi \times 10^3$ (rad/s)

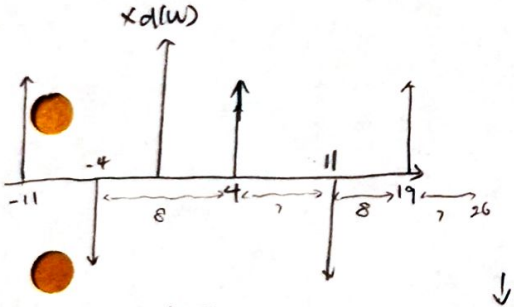
[minimum sample rate]

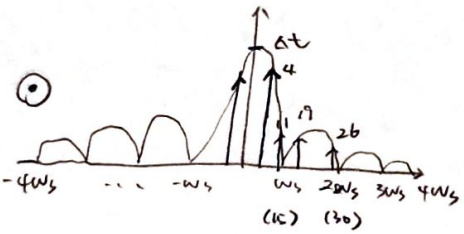
let $|\frac{1}{\sqrt{1+(w/w_0)^2}}| = \frac{1}{20}$, $1 + (w/w_0)^2 = 4$, $(w/w_0) = \sqrt{3}$, $w = \sqrt{3}\, w_0 = 25.9808 \approx 26$

$x_s \geq 26 - (-13) = 39\pi \times 10^3$ rad/s

② $x(t) = \sin(2\pi f_0 t) = \left[e^{j2\pi f_0 t} - e^{j2\pi f_0 t}\right]/j$







$w = 2\pi f$

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

$|H_{ZOH}(w)| = \Delta t \cdot \frac{\sin(\pi w/w_s)}{\pi w/w_s}$

fundamental freq: 4 kHz

→ harmonics frequency: 11 . 19 . 26 kHz.

amplitude: $|H_{ZOH}(w)| \cdot X_d(w)$