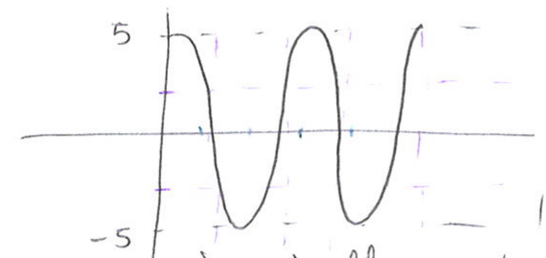
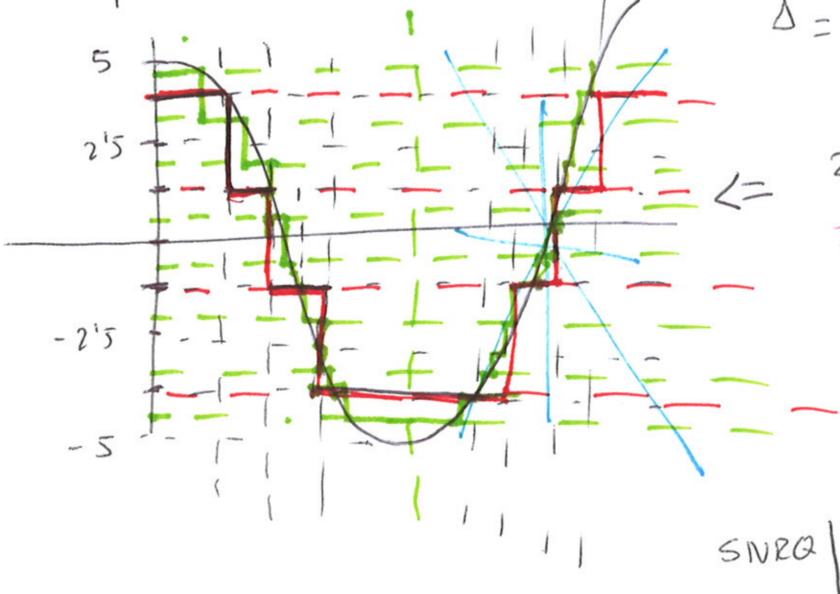
① $V = 10$ voltios valor de pico



cuantificación huelle



2 bits $2^2 = 4$ nivels

$$\Delta = \frac{2.5}{2^2} = 2.5$$

3 bits $2^3 = 8$ nivels

$$\Delta = \frac{2.5}{2^3} = \frac{5}{4} = 1.25$$

⇐ 2 bits rojo
3 bits verde

$$SNRQ = \frac{\sigma_x^2}{\sigma_e^2}$$

$$\left.SNRQ\right|_{B=2} = \frac{3 \cdot 2^2}{X_{max}^2}\sigma_x^2$$

$$\left.SNRQ\right|_{B=3} = \frac{3 \cdot 2^3}{X_{max}^2}\sigma_x^2$$

$$\Rightarrow \left.SNRQ\right|_{B=3} = 2\left.SNRQ\right|_{B=2}$$

2.- $x(n) = \delta(n-2) - 2\delta(n-4) + 3\delta(n-6)$

$h(n) = 2\delta(n+3) + \delta(n) + 2\delta(n-2) + \delta(n-3)$

$y(n) = x(n) * h(n)$; $X(z) = z^{-2} - 2z^{-4} + 3z^{-6}$; $H(z) = 2z^3 + 1 + 2z^{-2} + z^{-3}$

$Y(z) = H(z)X(z) = (z^{-2} - 2z^{-4} + 3z^{-6})(2z^3 + 1 + 2z^{-2} + z^{-3}) =$

$2z + z^{-2} + \cancel{2z^{-4}} + z^{-5} - 4z^{-1} - \cancel{2z^{-4}} - 4z^{-6} - 2z^{-7} + 6z^{-3} + 3z^{-6} +$

$+ 6z^{-8} + 3z^{-9} = 2z - 4z^{-1} + z^{-2} + 6z^{-3} + z^{-5} - z^{-6} - 2z^{-7} + 6z^{-8} + 3z^{-9}$

$y(n) = 2\delta(n+1) + \delta(n-2) - 4\delta(n-1) + 6\delta(n-3) + \delta(n-5) - \delta(n-6)$
$- 2\delta(n-7) + 6\delta(n-8) + 3\delta(n-9)$

3.- $y(n) = y(n-1) - y(n-2) + 0.5x(n) + 0.5x(n-1)$ ②

a) la respuesta al impulso

b) La " del sistema a la entrada cero

c) la respuesta del sistema a la entrada $x(n) = (0.5)^n u(n)$ y las C.I $y(-1) = 0.75$ e $y(-2) = 0.25$

a) C.I nulas

$$y(n) - y(n-1) + y(n-2) = 0.5x(n) + 0.5x(n-1)$$

E. homogénea $y(n) - y(n-1) + y(n-2) = 0$

$$\lambda^{n-2}[\lambda^2 - \lambda^1 + 1] = 0 \qquad \lambda_1 = \frac{1}{2} + \frac{\sqrt{3}}{2}i$$

$$\lambda_2 = \frac{1}{2} - \frac{\sqrt{3}}{2}i$$

$$y_h(n) = C_1(\lambda_1)^n + C_2(\lambda_2)^n$$

$y(0) = -0.5$

$y(1) = y(0) + 0.5 = -1$

$y_h(0) = C_1 + C_2 = 0.5$

$y_h(1) = C_1\left(\frac{1}{2} + \frac{\sqrt{3}}{2}i\right) + C_2\left(\frac{1}{2} - \frac{\sqrt{3}}{2}i\right) = 1$

$$y_h(n) = \left(\frac{1}{4} + \frac{3}{4\sqrt{3}}i\right)\left(\frac{1}{2} + \frac{\sqrt{3}}{2}i\right)^n + \left(\frac{1}{4} - \frac{3}{4\sqrt{3}}i\right)\left(\frac{1}{2} + \frac{\sqrt{3}}{2}i\right)^n$$

b) Si las C.I son cero la respuesta del sistema es cero

c) $x(n) = (0.5)^n u(n)$ $\qquad y(-1) = 0.75$

$y(-2) = 0.25$

$$y_p(n) = k'(0.5)^n u(n)$$

$$K(0.5)^n u(n) - k(0.5)^{n-1}u(n-1) + K(0.5)^{n-2}u(n-2) = 0.5(0.5)^n u(n) + 0.5(0.5)^{n-1}u(n-1)$$

evaluamos en $n=2$ para obtener el valor de k'

$$K\,0.5^2 - K\,0.5 + K' = 0.5^3 + 0.5^2$$

$$K[0.5^2 - 0.5 + 1] = \cancel{0.5\,0.5^2}\ 0.5^3 + 0.5^2$$

$$K' = \frac{0.5^3 + 0.5^2}{0.5^2 + 0.5} = \frac{0.5^2 + 0.5}{0.5 + 1} = \cancel{\frac{0.5[0.5+1]}{(0.5+1)}} = 0.5$$

$$y_p(n) = 0.5(0.5)^n u(n) = (0.5)^{n+1}u(n)$$

$$y_h(n) = C_1\left(\frac{1}{2} + \frac{\sqrt{3}}{2}i\right)^n + C_2\left(\frac{1}{2} - \frac{\sqrt{3}}{2}i\right)^n = A_1 e^{j\pi/3} + A_2 e^{-j\pi/3}$$

Calculamos C_1 y C_2 de la solución total $y_t(n) = y_h(n) + y_p(n)$ teniendo en cuenta las C.I.

$$y_t(n) = (0.5)^{n+1} u(n-1) + C_1\left(\frac{1}{2} + \frac{\sqrt{3}}{2}i\right)^n + C_2\left(\frac{1}{2} - \frac{\sqrt{3}}{2}i\right)^n$$

$$y(0) = y(-1) - y(-2) + 0.5\,x(0) + 0.5\,x(-1) = 0.75 - 0.25 + 0.5 = 1$$

$$y(1) = y(0) - y(-1) + 0.5\,x(1) + 0.5\,x(0) = 1 - 0.75 + 0.25 + 0.5 = 1$$

$$\left.\begin{array}{l} y(0) = 0.5 + A_1 + A_2 = 1 \\ y(1) = 0.25 + A_1 e^{j\pi/3} + A_2 e^{-j\pi/3} = 1 \end{array}\right\} \Rightarrow \begin{bmatrix} 1 & 1 \\ e^{j\pi/3} & e^{-j\pi/3} \end{bmatrix} \begin{bmatrix} A_1 \\ A_2 \end{bmatrix} = \begin{bmatrix} 0.5 \\ 0.75 \end{bmatrix}$$

$$y(n) = (0.5)^{n+1} + \frac{\sqrt{3}}{2}\,\text{sen}\left(\frac{\pi n}{3}\right) - \frac{2\sqrt{3}}{2}\,\text{sen}\left[(n-1)\,\pi/3\right]$$

⋮

(4) Intereses mensuales a razón del 3% por año de interés compuesto

100 € al mes durante 6 años $\quad 6 \times 12 = 72$ meses

$$y(n) = y(n-1) + \beta\, y(n-1) + x(n)$$

$$\beta = \frac{0.03}{12} \qquad y(n) = (1+\beta)\,y(n-1) + x(n)$$

$x(n) = 100\,u(n)$

a) resolvemos mediante la ecuación en diferencias:

E. homogénea $\quad y(n) - (1+\beta)\,y(n-1) = 0$

$$\lambda^n\,[\lambda - 1 - \beta] = 0 \qquad \lambda = 1+\beta$$

$$\lambda = (1+\beta)^n$$

$$y_h(n) = C_1 (1+\beta)^n$$

Sol. $\quad x(n) = 100\,u(n)$

Sol. particular $\quad y_p(n) = K\, 100\, u(n)$

$$K \cdot 1\cancel{00}\,u(n) - (1+\beta)\,K\,\cancel{100}\,u(n-1) = \cancel{100}\,u(n)$$

en $n=1$ $\Rightarrow$ $K = \frac{-1}{\beta}$

$K[1 - 1 - \beta] = 1$

$$y_{total}(n) = y_h(n) + y_p(n) = \left[C_1(1+\beta)^n - \frac{1}{\beta}100\right] u(n)$$

C.I $\quad y(-1) = 0$

$y(0) = (1+\beta)\, y(-1) + 100 = 100$

$y_{total}(0) = (1+\beta)^0 C_1 - \frac{1}{\beta} 100 = 100 \Rightarrow \cancel{C_1 = 400100}$

$C_1 = 40100$

$$y_{total}(n) = 40100\,(1+0.0025)^n - \frac{100}{0.0025}$$

al cabo de 72 meses

$$y_{total}(72) = 40100(1+0.0025)^{72} - \frac{100}{0.0025} = 7.366'1\ €$$

b) No se deposita ningun dinero en los 12 meses siguientes a la apertura de la cuenta.

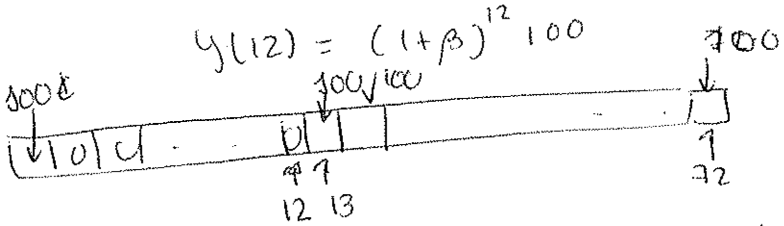
b1 $\rightarrow$ dinero depositado despues de los 12 primeros meses.

$y(n) = (1+\beta)\, y(n-1) + 100\,\delta(n) \qquad x(n) = 100\,\delta(n)$

$y(0) - (1+\beta)\, y(-1) = 100 \;;\quad C_1 = 100$

$y(n) = (1+\beta)^n\, 100$

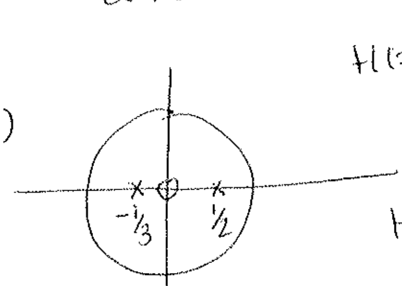
$y(12) = (1+\beta)^{12}\, 100$



la siguiente etapa es igual que el apartado a y con C.I considerando 5 años (a partir del mes 13) y con C.I $y(-1) = (1+\beta)^{12}\, 100$ que es el dinero acumulado hasta el mes 12.

$H(z)\big|_{z=1} = 6$

(5) a)



$$H(z) = \frac{z^2}{(z+\frac{1}{3})(z-\frac{1}{2})} \cdot G = \frac{G}{(1+\frac{1}{3}z^{-1})(1-\frac{1}{2}z^{-1})}$$

$$H(z)\big|_{z=1} = 6 = \frac{G}{(\frac{4}{3})(\frac{1}{2})} \Rightarrow G = 6 \cdot \frac{2}{3} = 4$$

$$H(z) = \frac{4z^2}{(z+\frac{1}{3})(z-\frac{1}{2})}$$

b) Respuesta del sistema cuando la entrada es

$$x(n) = 50 + 10\cos(20\pi t) + 30\cos(40\pi t) \Rightarrow t \to nT = n/F = n/40$$

se aplica el principio de superposición

$$x(n) = x_1(n) + x_2(n) + x_3(n)$$

$$x_1(n) = 50$$

$$x_2(n) = \cancel{10\cos(2\cdot 10\pi n)} = 10\cos(20\pi n/40) = 10\cos\left(\frac{\pi}{2}n\right)$$

$$x_3(n) = 30\cos(2\cdot 20\pi n) = 30\cos(40\pi n/40) = 30\cos(\pi n)$$

$$Y_1(e^{j\omega}) = H(e^{j\omega})\Big|_{\omega=0} \cdot 50 = \frac{4 \cdot 50}{\frac{4}{3}\cdot\frac{1}{2}} = 300$$

$$H(e^{j\omega}) = \frac{4(e^{j\omega})^2}{(e^{j\omega}+\frac{1}{3})(e^{j\omega}-\frac{1}{2})}$$

$$;\ y_1(n) = 300$$

$$Y_2(e^{j\omega}) = H(e^{j\omega})\Big|_{\omega=\pi/2} 10\cdot e^{-j\pi/2} = \left|H(e^{j\omega})\right|_{\omega=\pi/2} 10\, e^{j(\theta_{\omega=\pi/2} - \pi/2)}$$

$$y_2(n) = \left|H(e^{j\omega})\right|_{\omega=\pi/2} \cdot 10\cos(\theta_{\omega=\pi/2} - \pi/2)$$

$$Y_3(e^{j\omega}) = H(e^{j\omega})\Big|_{\omega=\pi} \cdot 30\, e^{-j\pi}$$

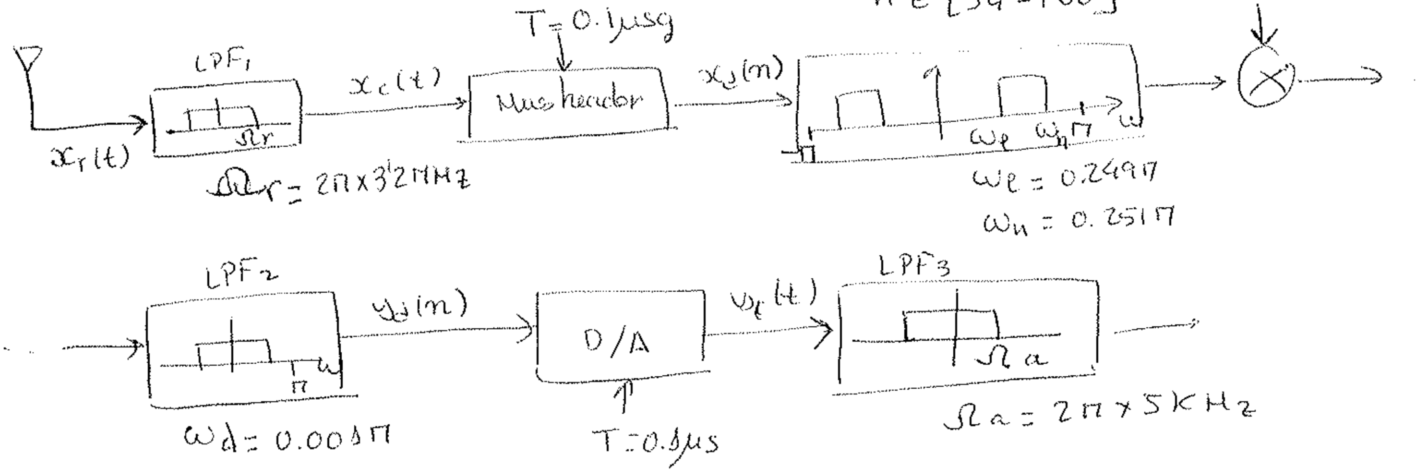
$$y_3(n) = \left|H(e^{j\omega})\right|_{\omega=\pi} 30\cos(\theta_{\omega=\pi} - \pi)$$

$$y(n) = y_1(n) + y_2(n) + y_3(n)$$

OJO: Hay que calcular $\begin{cases} \theta_{\omega=\pi/2} & \left|H(e^{j\omega})\right|_{\omega=\pi/2} \\ \theta_{\omega=\pi} & \left|H(e^{j\omega})\right|_{\omega=\pi} \end{cases}$

(6) $2\pi(f_c - 5KHz) < \omega < 2\pi(f_c + 5KHz)$ $f_c = \frac{\omega}{2\pi} = n \times 10\ KHz$ (4)

$n \in [54 - 160]$



$x_d(n) = x_c(nT)$

$y_c(t) = \sum_{n=-\infty}^{\infty} y_d(n)\,\delta(t - nT)$

Determinar f_c para la stación de AM que sle receptor puede detectar

$\omega_r = 2\pi \times 3'2\ MHz$

$n \times 10KHz + 5KHz \leq 3'2\ MHz$

$n \times 10 \cdot 10^3 + 5 \cdot 10^3 \leq 3'12 \cdot 10^6 \Rightarrow n \leq \frac{3'2 \cdot 10^6 - 5 \cdot 10^3}{10 \cdot 10^3} = 3'2 \cdot 10^2 - 0.5$

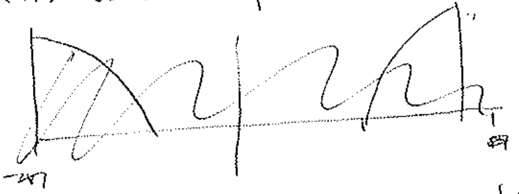
$f_c \leq n \times 10KHz$ $0 < n < 320$

$T = 0.1\mu sg = 0.1\, 10^{-6} sg = 10^{-7} sg.$ $F_s = \frac{1}{T} = 10^7\ Hz = 10MHz$

$f_{max} = 3'195MHz$ $F_s = 10MHz$ $F_s > 2 f_{max} \Rightarrow$ luego se respeta el teorema de muestreo

$x_d(n)$ tiene componente máxima de frecuencia normalizada $\frac{f_{max}}{F_s}$

$\Omega_{max} = \frac{f_{max}}{F_s} 2\pi$



$x_d(n)$ la filtramos por un filtro paso banda $\Omega_e = 0.249\pi$ $\Omega_h = 0.251\pi$

$f_e = \frac{0.249\cancel{\pi}}{2\cancel{\pi}} = 0.1245 \Rightarrow F_e = 0.1245 F_s$

$f_h = \frac{0.251\cancel{\pi}}{2\cancel{\pi}} = 0.1255 \Rightarrow F_h = 0.1255 F_s$

$F_l = 0.1245 \times 10^7 \ Hz = 1.245 \ MHz$

$F_h = 0.1255 \times 10^7 \ Hz = 1.255 \ MHz$

$n \times 10 kHz - 5 kHz \geq 1.245 . 10^6 \Rightarrow n \geq \frac{(1245+5) 10^3}{10^4} = 125$

$n \times 10 kHz + 5 kHz \leq 1.255 . 10^6$

$n \leq \frac{(1255-5) 10^3}{10^4} = 125$

$n = 125$