$T = 10\,ms$

$C_0 = 5$

$C_1 = 3+3j$

$C_2 = 2-j$

$C_3 = 0.5+j$

$C_4 = 0.2-0.2j$

$C_5 = 0.3j$

$C_6 = 0.05$

a)
$$H(f) = \begin{cases} (1-f/600)\,e^{-j0.02\pi f} & \text{si } |f| \leq 600\,Hz \\ 0 & \text{si } |f| > 600\,Hz. \end{cases}$$

Sabemos que $w_n = \frac{2\pi}{T} \cdot n$ y que $w = 2\pi f$

- $w_0 = 0 \rightsquigarrow C_0 = 5$, $f_0 = \frac{w_0}{2\pi} = \underline{0\,Hz}$
- $w_1 = \frac{2\pi}{T}$, $f_1 = \frac{w_1}{2\pi} = \frac{2\pi}{2\pi T} = \frac{1}{T} = \frac{1}{10\,ms} = \frac{1}{10 \cdot 10^{-3}\,s} = \underline{100\,Hz}$
- $w_2 = \frac{2\pi}{T} \cdot 2$, $f_2 = \frac{w_2}{2\pi} = \frac{2\pi \cdot 2}{2\pi} \cdot \frac{1}{T} = \frac{2}{T} = \frac{2}{10^{-2}}\,Hz = \underline{200\,Hz}$
- $w_3 = \frac{2\pi}{T} \cdot 3$, $f_3 = \frac{w_3}{2\pi} = \frac{2\pi \cdot 3}{2\pi} \cdot \frac{1}{T} = \frac{3}{T} = \underline{300\,Hz}$
- $w_4 = \frac{2\pi}{T} \cdot 4$, $f_4 = \frac{w_4}{2\pi} = \frac{2\pi \cdot 4}{2\pi} \cdot \frac{1}{T} = \frac{4}{T} = \underline{400\,Hz}$
- $w_5 = \frac{2\pi}{T} \cdot 5$, $f_5 = \frac{w_5}{2\pi} = \frac{2\pi \cdot 5}{2\pi} \cdot \frac{1}{T} = \frac{5}{T} = \underline{500\,Hz}$.
- $w_6 = \frac{2\pi}{T} \cdot 6$, $f_6 = \frac{w_6}{2\pi} = \frac{2\pi \cdot 6}{2\pi} \cdot \frac{1}{T} = \frac{6}{T} = \underline{600\,Hz}$.

- Calculemos los coeficientes despues de pasar por el sistema

- $\boxed{C_0'} = C_0 \cdot H(0) = C_0 = \boxed{5}$

$H(0) = (1 - \frac{0}{600})\, e^{+0} = 1$

- $C_1' = C_1 \cdot H(100)$

$H(100) = (1 - \frac{100}{600}) \cdot e^{-j \cdot 0.02 \cdot \pi \cdot 100} = \frac{5}{6} e^{-j\pi 2}$

$\boxed{C_1'} = C_1 \cdot \frac{5}{6} e^{-j\pi 2} = \frac{5}{6} C_1 \cdot (\cos(-2\pi) + j \cdot \mathrm{sen}(-2\pi)) =$

$= \frac{5}{6} C_1 = \frac{5}{6} \cdot (3 + 3j) = \boxed{\frac{5}{2} + \frac{5}{2} j}$

- $C_2' = C_2 \cdot H(200)$

$H(200) = (1 - \frac{200}{600})\, e^{-j \cdot 0.02 \cdot \pi \cdot 200} = \frac{2}{3} e^{-j4\pi}$

$\boxed{C_2'} = C_2 \cdot \frac{2}{3} e^{-j4\pi} = \frac{2}{3} C_2 \cdot (\cos(-4\pi) + j \cdot \mathrm{sen}(-4\pi)) = \frac{2}{3} C_2 =$

$= \frac{2}{3}(2 - j) = \boxed{\frac{4}{3} - \frac{2}{3} j}$

$C_3' = C_3 \cdot H(300)$

$H(300) = (1 - \frac{300}{600})\, e^{-j \cdot 0.02 \cdot \pi \cdot 300} = \frac{1}{2} e^{-j6\pi}$

$\boxed{C_3'} = C_3 \cdot \frac{1}{2} e^{-j6\pi} = \frac{1}{2} C_3 (\cos(-6\pi) + j \cdot \mathrm{sen}(-6\pi)) = \frac{1}{2} C_3 =$

$= \frac{1}{2}(0.5 + j) = \boxed{\frac{1}{4} + \frac{1}{2} j}$

$C_4' = C_4 \cdot H(400)$

$$H(400) = \left(1 - \frac{400}{600}\right) e^{-j0.02\pi \cdot 400} = \left(1 - \frac{2}{3}\right) e^{-j8\pi} = \frac{1}{3} e^{-j8\pi}$$

$$C_4' = C_4 \cdot \frac{1}{3} e^{-j8\pi} = \frac{1}{3} C_4 \cdot (\cos(-8\pi) + j \cdot \mathrm{sen}(-8\pi)) = \frac{1}{3} C_4$$

$$\boxed{C_4'} = \frac{1}{3}(0.2 - 0.2j) = \boxed{\frac{2}{30} - \frac{2}{30}j}$$

$C_5' = C_5 \cdot H(500)$

$$H(500) = \left(1 - \frac{500}{600}\right) e^{-j0.02\pi 500} = \frac{1}{6} e^{-j10\pi}$$

$$\boxed{C_5'} = C_5 \cdot \frac{1}{6} e^{-j10\pi} = \frac{1}{6} C_5 = \frac{1}{6}(0.3j) = \frac{3}{60} j = \boxed{\frac{1}{20}j}$$

$C_6' = C_6 \cdot H(600)$

$$H(600) = \left(1 - \frac{600}{600}\right) e^{-j0.02\pi 600} = 0$$

$$\boxed{C_6' = C_6 \cdot 0 = 0}$$

- Determinar la señal resultante en el dominio del tiempo.

$$g(t) = \frac{1}{T} \sum_{-\infty}^{\infty} C_n' e^{jw_n t}$$

C_n' para $|n| \geq 6$ es $C_n' = 0$ pues $H(f) = 0$ para esos $|f| > 600\,Hz$.

entonces nos queda

$$g(t) = \frac{1}{T} \sum_{-5}^{5} C_n' e^{jw_n t}$$

$C_{-1}' = \overline{C_1'} = (\text{conjugado}) = \frac{5}{2} - \frac{5}{2}j$

$C_{-2}' = \overline{C_2'} = \frac{4}{3} + \frac{2}{3}j$

$C_{-3}' = \overline{C_3'} = \frac{1}{4} - \frac{1}{2}j$

$C_{-4}' = \overline{C_4'} = \frac{2}{30} + \frac{2}{30}j$

$C_{-5}' = \overline{C_5'} = -\frac{1}{20}j$

$$g(t) = \frac{1}{T} \sum_{-5}^{5} c_n' e^{j w_n t}$$

$$w_0 = 0$$

$$w_1 = \frac{2\pi}{T} = \frac{2\pi}{10^{-2}\,s} = 2\pi \cdot 100 \text{ rad/s} = 200\pi \text{ rad/s}$$

$$w_2 = \frac{4\pi}{T} = \frac{4\pi}{10 \cdot 10^{-3}} = 400\pi \text{ rad/s}$$

$$w_3 = \frac{6\pi}{T} = 600\pi \text{ rad/s}$$

$$w_4 = \frac{8\pi}{T} = 800\pi \text{ rad/s}$$

$$w_5 = 1000\pi \text{ rad/s}$$

$$g(t) = \frac{1}{10^{-2}} \cdot \left(c_{-5}' e^{-j \cdot 1000\pi t} + \dots + c_5' \cdot e^{j 1000\pi t} \right)$$

- Distorsiones

- Hay distorsión de atenuación, veamos por qué:

$$H(f) = \left(1 - \frac{f}{600}\right) e^{-j \frac{2}{100} \pi f}$$ para $|f| \leq 600$ Hz. (donde están nuestros armónicos)

$$H(f) = \left(1 - \frac{f}{600}\right) \cdot \left(\cos\left(-\frac{2\pi f}{100}\right) + j \cdot \text{sen}\left(-\frac{2\pi f}{100}\right)\right)$$

$$\underset{\text{modulo}}{|H(f)|} = \sqrt{\left(1 - \frac{f}{600}\right)^2 \cdot \underbrace{\left(\cos^2\left(\frac{-2\pi f}{100}\right) + \text{sen}^2\left(-\frac{2\pi f}{100}\right)\right)}_{1}} = 1 - \frac{f}{600}$$

$|H(f)| = 1 - \frac{f}{600}$ si $|f| \leq 600$ Hz. Hay distorsión de atenuación porque $|H(f)|$ no es constante para toda frecuencia. $|f| \leq 600$ Hz y cada armónico cambia de forma diferente.

· Calculemos ahora la fase:

$$\phi(f) = \operatorname{arctg}\left(\frac{-\operatorname{sen}\left(-\frac{2\pi f}{100}\right)}{\cos\left(-\frac{2\pi f}{100}\right)}\right) = \operatorname{arctg}\left(-\operatorname{tg}\left(-\frac{2\pi f}{100}\right)\right) = \operatorname{arctg}\left(\operatorname{tg}\left(\frac{2\pi f}{100}\right)\right) = \frac{2\pi f}{100}$$

No hay distorsión de retardo porque la fase es lineal.

b) El A.B del medio de transmisión, es decir, de su función de transferencia es $w_0 = \frac{1}{RC} = 100\pi$ rad/s. Como todos los armónicos de la señal son de frecuencia mucho mayor que el AB esto implica que no se transmitirá correctamente.