- Comunicaciones I

Santiago Ramírez Avenas.

- Pregunta 1 V
- Pregunta 2 V
- Pregunta 3 F
- Pregunta 4 V
- Pregunta 5 V
- Pregunta 6 F
- Pregunta 7 V
- Pregunta 8 F
- Pregunta 9 Ninguna de las anteriores
- Pregunta 10 Ninguna de las anteriores.
- Pregunta 11 Con $n=5$ → Procedimiento en las otras hojas.

$$f(t) = -\frac{6}{5} + \sum_{n=1}^{\infty} \frac{-5}{n^2\pi^2}\left[\left[1-\cos\left(\frac{2\pi n}{5}\right)+\cos\left(\frac{6\pi n}{5}\right)+\cos\left(\frac{4\pi n}{5}\right)\right]\cdot\cos\left(\frac{2\pi n t}{5}\right)+\left[\operatorname{Sen}\left(\frac{2\pi n}{5}\right)-\operatorname{Sen}\left(\frac{6n\pi}{5}\right)+\operatorname{Sen}\left(\frac{4\pi n}{5}\right)\right]\cdot\operatorname{Sen}\left(\frac{2\pi n t}{5}\right)\right] \Rightarrow \text{Con } n=5$$

$$f(t) = -\frac{6}{5} \sum_{n=1}^{5} \frac{-5}{(1)^2\pi^2}\left[\left[1-\cos\left(\frac{2\pi(1)}{5}\right)+\cos\left(\frac{6\pi(1)}{5}\right)+\cos\left(\frac{4\pi(1)}{5}\right)\right]\cdot\cos\left(\frac{2\pi(1)t}{5}\right)+\left[\operatorname{Sen}\left(\frac{2\pi(1)}{5}\right)-\operatorname{Sen}\left(\frac{6(1)\pi}{5}\right)+\operatorname{Sen}\left(\frac{4\pi(1)}{5}\right)\right]\cdot\operatorname{Sen}\left(\frac{2\pi(1)t}{5}\right)\right] - \frac{5}{(2)^2\pi^2}\left[\left[1-\cos\left(\frac{2\pi(2)}{5}\right)+\cos\left(\frac{6\pi(2)}{5}\right)+\ldots\right.\right.$$

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$$+\cos\left(\frac{4\pi(2)}{5}\right)\Big]\cdot\cos\left(\frac{2\pi(2)}{5}t\right)+\left[\operatorname{Sen}\left(\frac{2\pi(2)}{5}\right)-\operatorname{Sen}\frac{6(2)\pi}{5}+\operatorname{Sen}\left(\frac{4\pi(2)}{5}\right)\right]$$

$$\operatorname{Sen}\left(\frac{2\pi(2)t}{5}\right)\cdot\frac{-5}{(2)^2\pi^2}\left[\left[1-\cos\left(\frac{2\pi(3)}{5}\right)+\cos\left(\frac{6\pi(3)}{5}\right)+\right.\right.$$

$$\left.\cos\left(\frac{4\pi(3)}{5}\right)\right]\cdot\cos\left(\frac{2\pi(3)t}{5}\right)+\left[\operatorname{Sen}\left(\frac{2\pi(3)}{5}\right)-\operatorname{Sen}\left(\frac{6(3)\pi}{5}\right)+\right.$$

$$\left.\operatorname{Sen}\left(\frac{4\pi(3)}{5}\right)\right]\operatorname{Sen}\left(\frac{2\pi(3)t}{5}\right)\Big]\cdot\frac{-5}{(4)^2\pi^2}\left[1-\cos\left(\frac{2\pi(4)}{5}\right)+\right.$$

$$\left.\cos\left(\frac{6\pi(4)}{5}\right)+\cos\left(\frac{4\pi(4)}{5}\right)\right]\cdot\cos\left(\frac{2\pi(4)t}{5}\right)+\left[\operatorname{Sen}\left(\frac{2\pi(4)}{5}\right)-\operatorname{Sen}\left(\frac{6(4)\pi}{5}\right)\right.$$

$$\left.+\operatorname{Sen}\left(\frac{4\pi(4)}{5}\right)\right]\cdot\operatorname{Sen}\left(\frac{2\pi(4)t}{5}\right)\cdot\frac{-5}{(5)^2\pi^2}\left[1-\cos\left(\frac{2\pi(5)}{5}\right)+\right.$$

$$\left.\cos\left(\frac{6\pi(5)}{5}\right)+\cos\left(\frac{4\pi(5)}{5}\right)\right]\cdot\cos\left(\frac{2\pi 5t}{5}\right)+\left[\operatorname{Sen}\left(\frac{2\pi(5)}{5}\right)-\right.$$

$$\left.\operatorname{Sen}\left(\frac{6\pi(5)}{5}\right)+\operatorname{Sen}\left(\frac{4\pi(5)}{5}\right)\right]\cdot\operatorname{Sen}\left(\frac{2\pi(5)t}{5}\right)$$

Dejo la Sumatoria expresada y sin simplificar por Cuestiones de tiempo.

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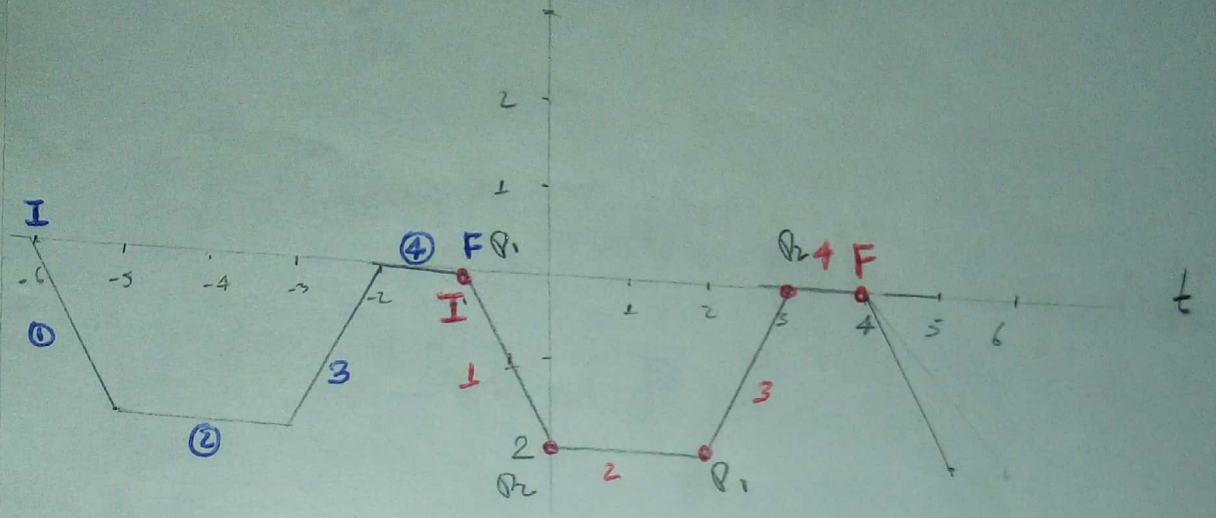
f(t) ①



$$f(t) = \begin{cases} -2t-2 & -1 \le t \le 0 \\ -2 & 0 \le t \le 2 \\ 2t-6 & 2 \le t \le 3 \\ 0 & 3 \le t \le 4 \rightarrow No \end{cases}$$

$\omega_0 = \frac{2}{5}\pi \quad T = 5 \quad P_1(-1,0) \; P_2(0,-2)$

$m = -2 \quad y = -2(t+1) = y = -2t-2$ ✓

$m = 2 \quad y = 2(t-3) \quad P_1(2,-2) \quad P_2(3,0)$

$y = 2t - 6$ ✓

Para $a_0 = \frac{2}{T}\int_{-T/2}^{T/2} f(t)\,dt \Rightarrow$

$$a_0 = \frac{2}{5}\left[\int_{-1}^{0} -2t-2\,dt + \int_{0}^{2} -2\,dt + \int_{2}^{3} 2t-6\,dt\right]$$

$$a_0 = \frac{2}{5}\left[-\int_{-1}^{0} -2t + \int_{-1}^{0} -2\,dt + \int_{0}^{2} -2\,dt + \int_{2}^{3} 2t + \int_{2}^{3} -6\,dt\right]$$

$$a_0 = \frac{2}{5}\left[-2\frac{t^2}{2}\Big|_{-1}^{0} - 2t\Big|_{-1}^{0} - 2t\Big|_{0}^{2} + 2\frac{t^2}{2}\Big|_{2}^{3} - 6\frac{t}{2}\Big|_{2}^{3}\right]$$

$$a_0 = \frac{2}{5}\left\{-t^2\Big|_{-1}^{0} - 2t\Big|_{-1}^{0} - 2t\Big|_{0}^{2} + t^2\Big|_{2}^{3} - 3t^2\Big|_{2}^{3}\right\}$$

$-1 \quad -4 \quad -1$

$$a_0 = \frac{2}{5}\{-1-4-1\} = \frac{2}{5}(-6) = \frac{-12}{5} = a_0$$

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- Para $a_n = \int_{-T/2}^{T/2} f(t)\cos(n\omega_0 t)\,dt$

$$a_n = \frac{2}{5}\left[\int_{-1}^{0}(-2t-2)\cos(n\omega_0 t)\,dt + \int_{0}^{2}\cos(n\omega_0 t)\,dt + \int_{2}^{3}(2t-6)\cos(n\omega_0 t)\,dt\right]$$

$$a_n = \frac{2}{5}\left[-2\int_{-1}^{0}t\cos(n\omega_0 t)\,dt - 2\int_{-1}^{0}\cos(n\omega_0 t) - 2\int_{0}^{2}\cos(n\omega_0 t)\,dt + 2\int_{2}^{3}t\cos(n\omega_0 t)\,dt - 6\int_{2}^{3}\cos(n\omega_0 t)\,dt\right]$$

$$a_n = \frac{2}{5}\left[-2\left[\underbrace{\int_{-1}^{0}t\cos(n\omega_0 t)}_{①} + \underbrace{\int_{-1}^{0}\cos(n\omega_0 t)}_{②} + \underbrace{\int_{0}^{2}\cos(n\omega_0 t)\,dt}_{③} - \underbrace{\int_{2}^{3}t\cos(n\omega_0 t)}_{④} + 3\underbrace{\int_{2}^{3}\cos(n\omega_0 t)}_{⑤}\right]\right]$$

Integrales de Tabla.

- Integral 1

$$\int_{-1}^{0}t\cos(n\omega_0 t)\,dt = \frac{1}{n\omega_0}\left[t\,\mathrm{Sen}(n\omega_0 t) + \frac{\cos(n\omega_0 t)}{n\omega_0}\right]\Bigg|_{-1}^{0}$$

Integral 2

$$\int_{-1}^{0}\cos(n\omega_0 t)\,dt = \frac{\mathrm{Sen}(n\omega_0 t)}{n\omega_0}\Bigg|_{-1}^{0}$$

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Integral 3

$$\int_0^2 \cos(n\omega_0 t)\,dt = \frac{\operatorname{Sen}(n\omega_0 t)}{n\omega_0}\Bigg|_0^2$$

Integral 4

$$-\int_2^3 t\cos(n\omega_0 t)\,dt = -\frac{1}{n\omega_0}\left[t\operatorname{Sen}(n\omega_0 t) + \frac{\cos(n\omega_0 t)}{n\omega_0}\right]\Bigg|_2^3$$

Integral 5

$$3\int_2^3 \cos(n\omega_0 t)\,dt = 3\frac{\operatorname{Sen}(n\omega_0 t)}{n\omega_0}\Bigg|_2^3$$

Agrupo.

- $\frac{1}{n\omega_0}\left[t\operatorname{Sen}(n\omega_0 t) + \frac{\cos(n\omega_0 t)}{n\omega_0} + \operatorname{Sen}(n\omega_0 t)\right]\Big|_{-1}^{0}$

  $\frac{1}{n\omega_0}\left[\operatorname{Sen}(n\omega_0 t)\,(t+1) + \frac{\cos(n\omega_0 t)}{n\omega_0}\right]\Big|_{-1}^{0}$

- $\frac{\operatorname{Sen}(n\omega_0 t)}{n\omega_0}\Big|_0^2$

- $-\frac{1}{n\omega_0}\left[t\operatorname{Sen}(n\omega_0 t) + \frac{\cos(n\omega_0 t)}{n\omega_0} - 3\operatorname{Sen}(n\omega_0 t)\right]\Big|_2^3$

  $\frac{-1}{n\omega_0}\left[\operatorname{Sen}(n\omega_0 t)\,(t-3) + \frac{\cos(n\omega_0 t)}{n\omega_0}\right]\Big|_2^3$

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Factorizo $\frac{1}{n\omega_0}$

$$\frac{1}{n\omega_0}\left[\left[\text{sen}(n\omega_0 t)(t+1) + \frac{\cos n\omega_0 t}{n\omega_0}\right]\Big|_{-1}^{0} + \text{Sen}\, n\omega_0 t\Big|_{0}^{2}\right.$$

$$\left.(-1)\left[\text{Sen}(n\omega_0 t)(t-3) + \frac{\cos n\omega_0 t}{n\omega_0}\right]\right]\Big|_{2}^{3}$$

Evaluamos.

① $\text{Sen}(n\omega_0 t)\underbrace{(t+1)}_{0} + \frac{\cos(n\omega_0 t)}{n\omega_0}\Big|_{-1}^{0} =$

$$\frac{1}{n\omega_0} - \left(\cos\left(\frac{2\pi n}{5}\right)\right) = \frac{1}{n\omega_0} - \frac{\cos\left(\frac{2\pi n}{5}\right)}{2\pi n} \checkmark 5.$$

② $\text{Sen}(n\omega_0 t)\Big|_{0}^{2} = \text{Sen}\left(\frac{4\pi n}{5}\right)$ ✓

③ $(-1)\left[\text{Sen}(n\omega_0 t)(t-3) + \frac{\cos(n\omega_0 t)}{n\omega_0}\right]\Big|_{2}^{3} =$

$$(-1)\left[\frac{\cos\left(\frac{6\pi n}{5}\right)(5)}{2\pi n} + \text{Sen}\left(\frac{4\pi n}{5}\right) - \frac{5\cos\left(\frac{4\pi n}{5}\right)}{2\pi n}\right] =$$

$$-\frac{\cos\left(\frac{6\pi n}{5}\right)(5)}{2\pi n} - \text{Sen}\left(\frac{4\pi n}{5}\right) + \frac{5\cos\left(\frac{4\pi n}{5}\right)}{2\pi n}$$ ✓

Agrupamos

$$\frac{1}{n\omega_0} - \frac{\cos\left(\frac{2\pi n}{5}\right)(5)}{2\pi n} + \text{Sen}\left(\frac{4\pi n}{5}\right) - \frac{\cos\left(\frac{6\pi n}{5}\right)(5)}{2\pi n} - \text{Sen}\left(\frac{4\pi n}{5}\right) +$$

$$\frac{5\cos\left(\frac{4\pi n}{5}\right)}{2\pi n} = \checkmark$$

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$$\frac{1}{n\omega_0}\cdot\frac{-\cos\left(\frac{2\pi n}{5}\right)(5)}{2\pi n}-\frac{\cos\left(\frac{6\pi n}{5}\right)(5)}{2\pi n}+\frac{\cos\left(\frac{4\pi n}{5}\right)(5)}{2\pi n}=$$

$\left(\frac{1}{n\omega_0}\cdot\frac{-4}{5}\right)=\frac{-2}{\pi n}$ → lo que estaba por fuera del paréntesis

$$\frac{-2}{\pi n}\left\{\frac{5}{n\cdot 2\pi}-\frac{\cos\left(\frac{2\pi n}{5}\right)(5)}{2\pi n}+\frac{\cos\left(\frac{6\pi n}{5}\right)(5)}{2\pi n}+\frac{\cos\left(\frac{4\pi n}{5}\right)(5)}{2\pi n}\right\}$$

$$\frac{-5}{n^2\pi^2}\left\{1-\cos\left(\frac{2\pi n}{5}\right)+\cos\left(\frac{6\pi n}{5}\right)+\cos\left(\frac{4\pi n}{5}\right)\right\}$$

a_n →

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⑤

Para $b_n = \frac{2}{T}\int_{-T/2}^{T/2} f(t)\,\mathrm{Sen}(n\omega_0 t)\,dt$

$$b_n = \frac{2}{5}\left[\int_{-1}^{0}(-2t-2)\,\mathrm{Sen}(n\omega_0 t)\,dt + \int_{0}^{2}-2\,\mathrm{Sen}(n\omega_0 t)\,dt + \int_{2}^{3}(2t-6)\,\mathrm{Sen}(n\omega_0 t)\,dt\right]$$

$$b_n = \frac{2}{5}\left[-2\left[\underbrace{\int_{-1}^{0} t\,\mathrm{Sen}(n\omega_0 t)}_{①} + \underbrace{\int_{-1}^{0}\mathrm{Sen}(n\omega_0 t)}_{②} + \underbrace{\int_{0}^{2}\mathrm{Sen}(n\omega_0 t)}_{③} - \underbrace{\int_{2}^{3} t\,\mathrm{Sen}(n\omega_0 t)}_{④} + 3\underbrace{\int_{2}^{3}\mathrm{Sen}(n\omega_0 t)}_{⑤}\right]\right]$$

Integrales de Tabla.

Integral 1

$$\int_{-1}^{0} t\,\mathrm{Sen}(n\omega_0 t)\,dt = \frac{1}{n\omega_0}\left[\frac{\mathrm{Sen}(n\omega_0 t)}{n\omega_0} - t\,\mathrm{Cos}(n\omega_0 t)\right]\Bigg|_{-1}^{0}$$

Integral 2

$$\int_{-1}^{0}\mathrm{Sen}(n\omega_0 t) = -\frac{\mathrm{Cos}(n\omega_0 t)}{n\omega_0}\Bigg|_{-1}^{0}$$

Integral 3

$$\int_{0}^{2}\mathrm{Sen}(n\omega_0 t)\,dt = -\frac{\mathrm{Cos}(n\omega_0 t)}{n\omega_0}\Bigg|_{0}^{2}$$

Integral 4

$$-\int_{2}^{3} t\,\mathrm{Sen}(n\omega_0 t) = -\frac{1}{n\omega_0}\left[\frac{\mathrm{Sen}(n\omega_0 t)}{n\omega_0} - t\,\mathrm{Cos}(n\omega_0 t)\right]\Bigg|_{2}^{3}$$

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Integrales

$$3\int_{2}^{3} \operatorname{Sen}(n\omega_0 t)\,dt = \left.\frac{-3\cos(n\omega_0 t)}{n\omega_0}\right|_{2}^{3}$$

Agrupo

- $-\frac{1}{n\omega_0}\left[-\frac{\operatorname{Sen}(n\omega_0 t)}{n\omega_0} + t\cos(n\omega_0 t) + \cos(n\omega_0 t)\right] =$

- $-\frac{1}{n\omega_0}\left[-\frac{\operatorname{Sen}(n\omega_0 t)}{n\omega_0} + \cos(n\omega_0 t)\,(-t+1)\right]\Big|_{-1}^{0}$

- $-\frac{1}{n\omega_0}\left(-\cos n\omega_0 t\right)\Big|_{0}^{2}$

- $-\frac{1}{n\omega_0}\left[\frac{\operatorname{Sen}(n\omega_0 t)}{n\omega_0} - t\cos(n\omega_0 t) + 3\cos(n\omega_0 t)\right]\Big|_{2}^{3}$

$$-\frac{1}{n\omega_0}\left[\frac{\operatorname{Sen}(n\omega_0 t)}{n\omega_0} + \cos(n\omega_0 t)\,(-t+3)\right]\Big|_{2}^{3}$$

Evalúo → Agrupo

$$-\frac{1}{n\omega_0}\left[\left[-\frac{\operatorname{Sen}(n\omega_0 t)}{n\omega_0} + \cos(n\omega_0 t)\,(t+1)\right]\Big|_{-1}^{0} + \cos(n\omega_0 t)\Big|_{0}^{2} + \left[\frac{\operatorname{Sen}(n\omega_0 t)}{n\omega_0} + \cos(n\omega_0 t)\,(-t+3)\right]\Big|_{2}^{3}\right]$$

$$\omega_0 = \frac{2}{5}\pi$$

Evalúo ①

$$-\frac{\operatorname{Sen}(n\omega_0 t)}{n\omega_0} + \cos(n\omega_0 t)\,(t+1)\Big|_{-1}^{0}$$

$$1 - \frac{\operatorname{Sen}\left(\frac{2\pi n}{5}\right)(5)}{2\pi n}$$

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Evalúo (2)

$$\cos(n\omega_0 t)\Big|_0^2 = \cos\left(\frac{4\pi n}{5}\right) + 1$$

Evalúo (3)

$$\frac{\operatorname{Sen}(n\omega_0 t)}{n\omega_0} + \cos(n\omega_0 t)(-t+3)\Big|_2^3 =$$

$$\frac{\operatorname{Sen}\left(\frac{6n\pi}{5}\right)(5)}{2\pi n} - \left(\frac{5\operatorname{Sen}\left(\frac{4\pi n}{5}\right)}{2\pi n} + \cos\left(\frac{4\pi n}{5}\right)\right) =$$

$$\frac{\operatorname{Sen}\left(\frac{6n\pi}{5}\right)(5)}{2\pi n} - \frac{5\operatorname{Sen}\left(\frac{4\pi n}{5}\right)}{2\pi n} - \cos\left(\frac{4\pi n}{5}\right)$$

Agrupo

$$1 - \frac{(5)\operatorname{Sen}\left(\frac{2\pi n}{5}\right)}{2\pi n} + \cos\left(\frac{4\pi n}{5}\right) - 1 + \frac{\operatorname{Sen}\left(\frac{6n\pi}{5}\right)(5)}{2\pi n} - \frac{5\operatorname{Sen}\left(\frac{4\pi n}{5}\right)}{2\pi n} -$$

$$\cos\left(\frac{4\pi n}{5}\right) \Rightarrow \left(-\frac{4}{5} \cdot -\frac{1}{n\omega_0}\right) \Rightarrow \frac{2}{\pi n}$$

$$\frac{2}{\pi n}\left(\frac{-5}{2\pi n}\right)\left\{\operatorname{Sen}\left(\frac{2\pi n}{5}\right) + \operatorname{Sen}\left(\frac{6n\pi}{5}\right) + \operatorname{Sen}\left(\frac{4\pi n}{5}\right)\right\} + 2\cos\left(\frac{4\pi n}{5}\right)$$

$$\frac{-5}{\pi n^2}\left\{\operatorname{Sen}\left(\frac{2\pi n}{5}\right) - \operatorname{Sen}\left(\frac{6n\pi}{5}\right) + \operatorname{Sen}\left(\frac{4\pi n}{5}\right)\right\} = bn$$

$bn \rightarrow$

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Reorganizo con los coeficientes

$$f(t) = \frac{1}{2}\left(\frac{-12}{5}\right) + \sum_{n=1}^{\infty} \frac{-5}{n^2\pi^2}\left[\left[\underbrace{1 - \cos\left(\frac{2\pi n}{5}\right) + \cos\left(\frac{6\pi n}{5}\right) + \cos\left(\frac{4\pi n}{5}\right)}_{An}\right] \cdot \cos\left(\frac{2\pi n t}{5}\right) + \left[\underbrace{\operatorname{Sen}\left(\frac{2\pi n}{5}\right) - \operatorname{Sen}\left(\frac{6n\pi}{5}\right) + \operatorname{Sen}\frac{4\pi n}{5}}_{Bn}\right] \cdot \operatorname{Sen}\left(\frac{2\pi n t}{5}\right)\right]$$

Con $n = 5$

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