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Ing. Eléctrica

Análisis de Sistemas Lineales

Respuesta de $V_L, V_C \ y \ V_R$ en un circuito RLC, ante la entrada de V_{in} señales de impulso, rampa y escalón unitario.

Componente	Tiempo	Frecuencia
Resistencia	$V_R = I * R$	$V_R = I_{(S)} * R$
Capacitor	$V_C = \frac{1}{C}\int_0^T I_C \ dt$	$V_C = \frac{I_{(S)}}{C * S}$
Inductor	$V_L = L \ \frac{di}{dt}$	$V_L = L * S * I_{(S)}$

Debemos calcular las funciones de transmisión para cada voltaje de salida.

Aplicando LVK obtenemos:

$$-V_{in}(t) + V_R(t) + V_C(t) + V_L(t) = 0$$

Aplicando Laplace.

$$L\left(-V_{in}(t) + I * R + \frac{1}{C}\int_0^T I_C \ dt + L \ \frac{di}{dt} = 0\right)$$

$$-V_{in}(s) + I_{(S)} * R + \frac{I_{(S)}}{C * S} + \ L * S * I_{(S)} = 0$$

- ***Inductor:***

$$\frac{I_{(S)}}{V_{in}(s)} = \frac{1}{R + L * S + \frac{1}{CS}} = \frac{S}{R * S + L * S^2 + \frac{1}{C}}$$

$$\frac{I_{(S)} * L * S}{V_{in}(s)} = \frac{S * L * S}{R * S + L * S^2 + \frac{1}{C}}$$

$$\frac{V_L(s)}{V_{in}(s)} = \frac{L * S^2}{R * S + L * S^2 + \frac{1}{C}}$$

- ***Resistencia:***

$$\frac{I_{(S)}}{V_{in}(s)} = \frac{1}{R + L * S + \frac{1}{CS}} = \frac{S}{R * S + L * S^2 + \frac{1}{C}}$$

$$\frac{I_{(S)} * R}{V_{in}(s)} = \frac{S * R}{R * S + L * S^2 + \frac{1}{C}}$$

$$\frac{V_R(s)}{V_{in}(s)} = \frac{S * R}{R * S + L * S^2 + \frac{1}{C}}$$

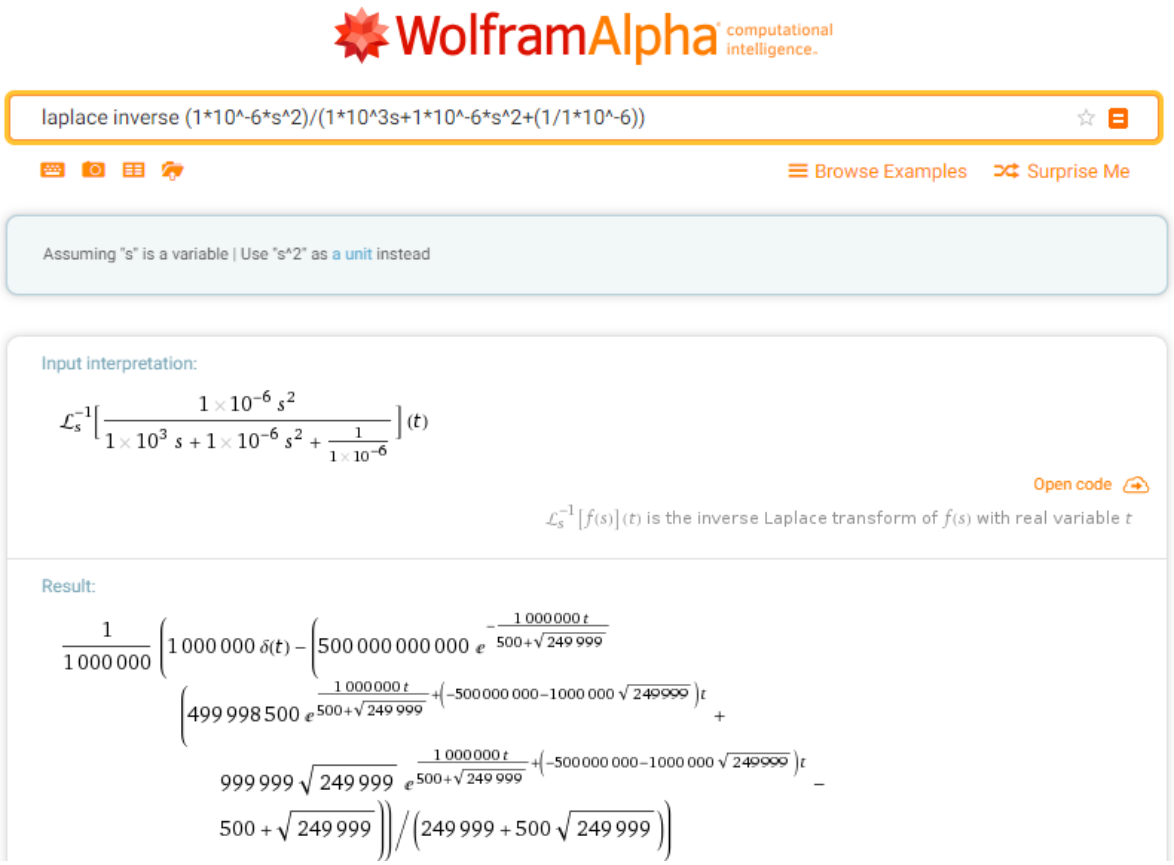
- ***Capacitor:***

$$\frac{I_{(S)}}{V_{in}(s)} = \frac{1}{R + L * S + \frac{1}{CS}} = \frac{S}{R * S + L * S^2 + \frac{1}{C}}$$

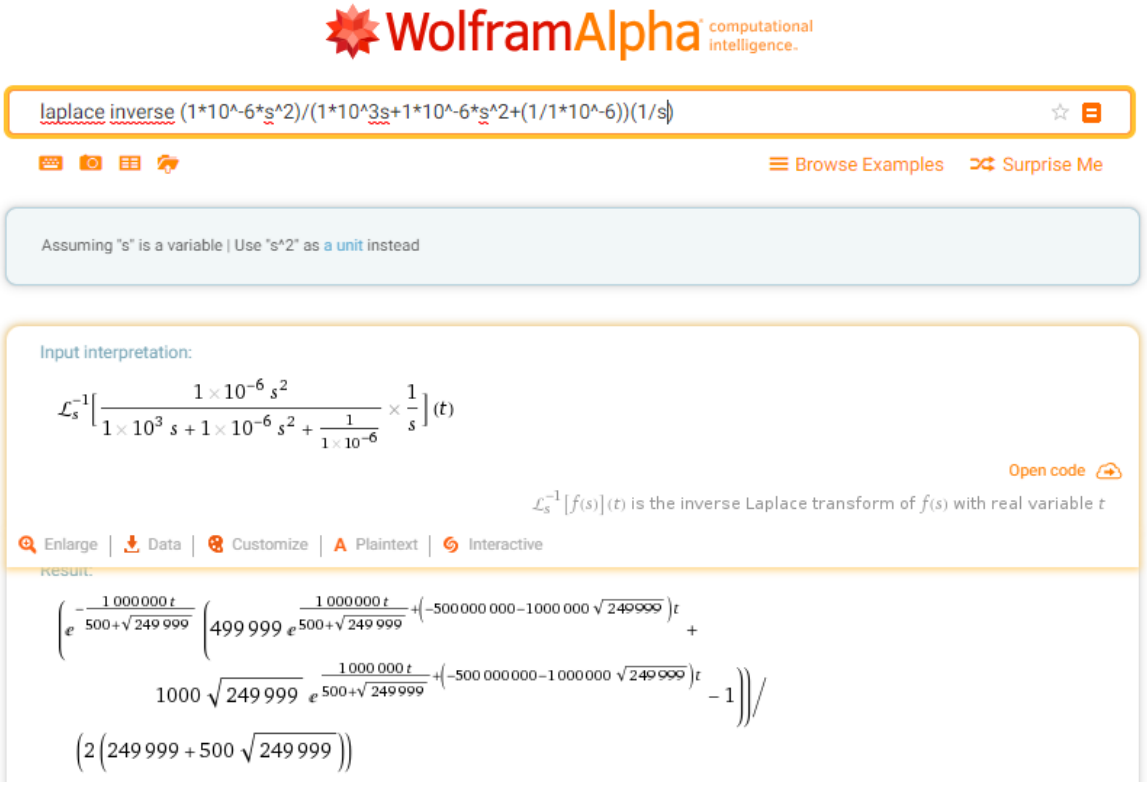
$$\frac{\frac{I_{(S)}}{CS}}{V_{in}(s)} = \frac{\frac{S}{CS}}{R * S + L * S^2 + \frac{1}{C}} = \frac{S}{CS\left(R * S + L * S^2 + \frac{1}{C}\right)} = \frac{S}{CR * S^2 + CL * S^3 + S}$$

$$\frac{V_C(s)}{V_{in}(s)} = \frac{S}{CR * S^2 + CL * S^3 + S}$$

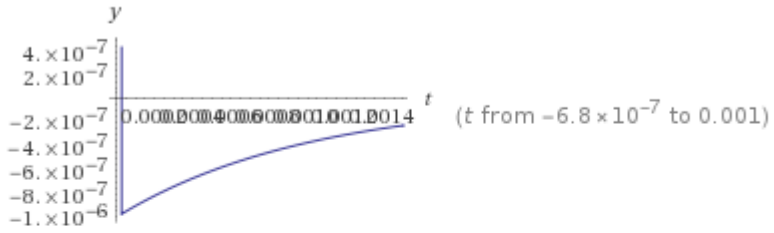
- *Respuesta a impulso del inductor:*

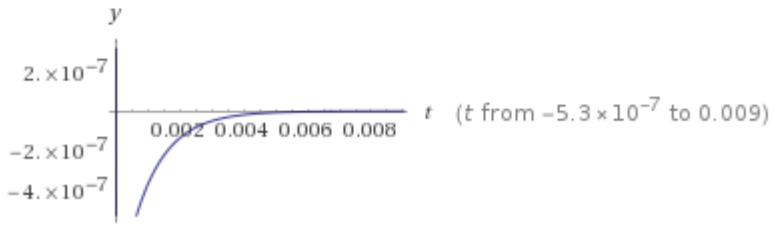


- *Respuesta a escalón unitario del inductor:*



Plots:





- *Respuesta a rampa del inductor:*

WolframAlpha computational intelligence.

laplace inverse (1*10^-6*s^2)/(1*10^3s+1*10^-6*s^2+(1/1*10^-6))(1/s^2)

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Assuming "s" is a variable | Use "s^2" as a unit instead

Input interpretation:

$$\mathcal{L}_s^{-1}\left[\frac{1\times10^{-6}\,s^2}{1\times10^{3}\,s+1\times10^{-6}\,s^2+\frac{1}{1\times10^{-6}}}\times\frac{1}{s^2}\right](t)$$

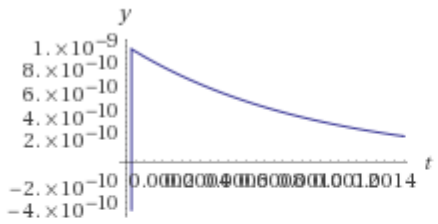
Open code

$\mathcal{L}_s^{-1}[f(s)](t)$ is the inverse Laplace transform of $f(s)$ with real variable t

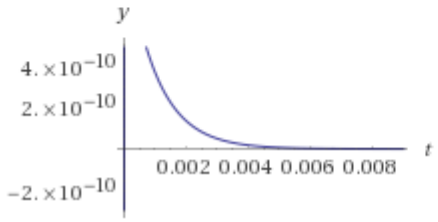
Result:

$$-\frac{\left(500+\sqrt{249\,999}\right)e^{-\frac{1\,000\,000\,t}{500+\sqrt{249\,999}}}\left(e^{\frac{1\,000\,000\,t}{500+\sqrt{249\,999}}+\left(-500\,000\,000-1\,000\,000\sqrt{249\,999}\right)t}-1\right)}{2\,000\,000\left(249\,999+500\sqrt{249\,999}\right)}$$

Plots:

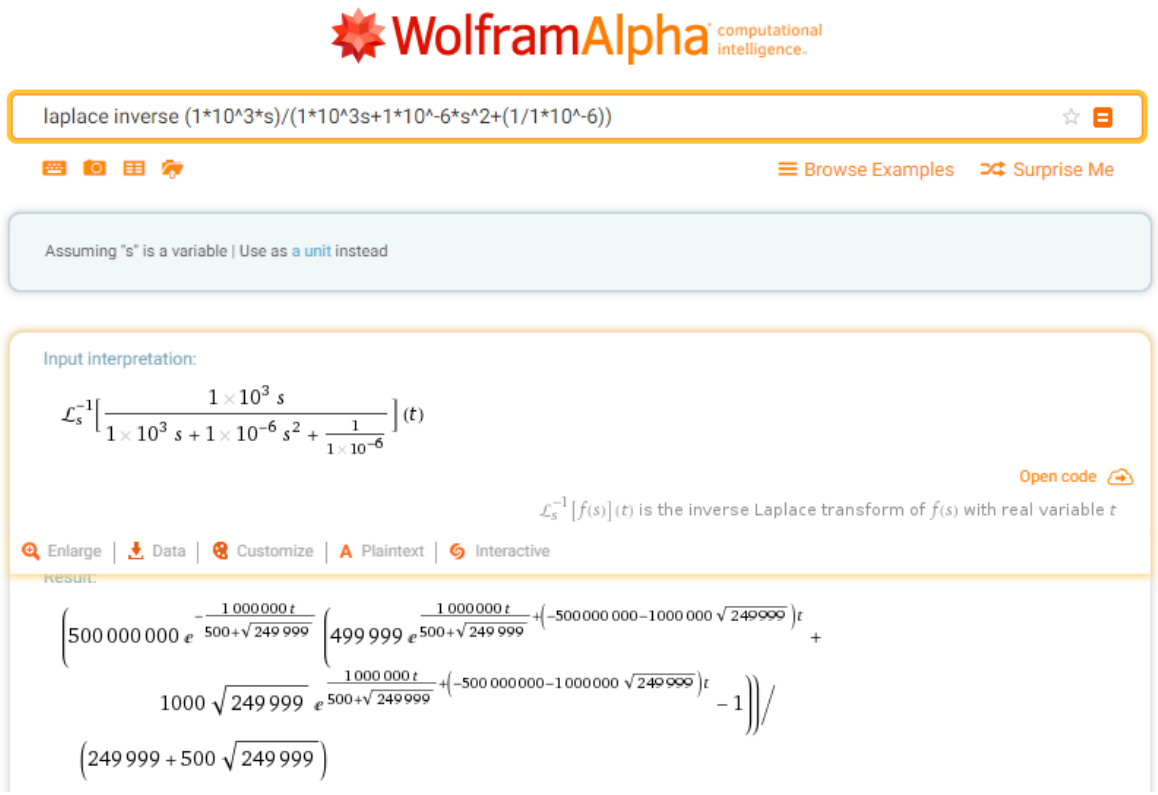


(t from -7.3×10^{-7} to 0.001)



(t from -5.3×10^{-7} to 0.009)

- *Respuesta a impulso de la resistencia:*



- *Respuesta a escalón unitario de la resistencia:*

WolframAlpha computational intelligence.

laplace inverse (1*10^3*s)/(1*10^3s+1*10^-6*s^2+(1/1*10^-6))(1/s)

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Assuming "s" is a variable | Use as a unit instead

Input interpretation:

$$\mathcal{L}_s^{-1}\left[\frac{1\times10^3\ s}{1\times10^3\ s+1\times10^{-6}\ s^2+\frac{1}{1\times10^{-6}}}\times\frac{1}{s}\right](t)$$

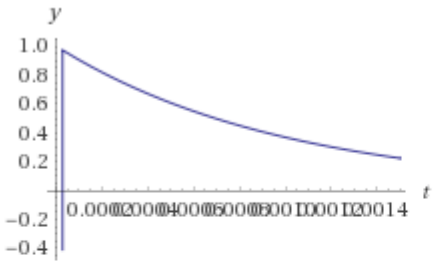
Open code

$\mathcal{L}_s^{-1}[f(s)](t)$ is the inverse Laplace transform of $f(s)$ with real variable t

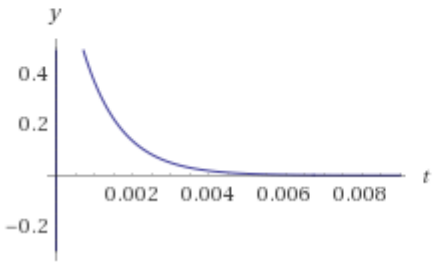
Result:

$$-\left(\left(500\left(500+\sqrt{249\,999}\right)e^{-\frac{1\,000\,000\,t}{500+\sqrt{249\,999}}}\left(e^{\frac{1\,000\,000\,t}{500+\sqrt{249\,999}}+\left(-500\,000\,000-1\,000\,000\sqrt{249\,999}\right)t}-1\right)\right)\Big/\left(249\,999+500\sqrt{249\,999}\right)\right)$$

Plots:

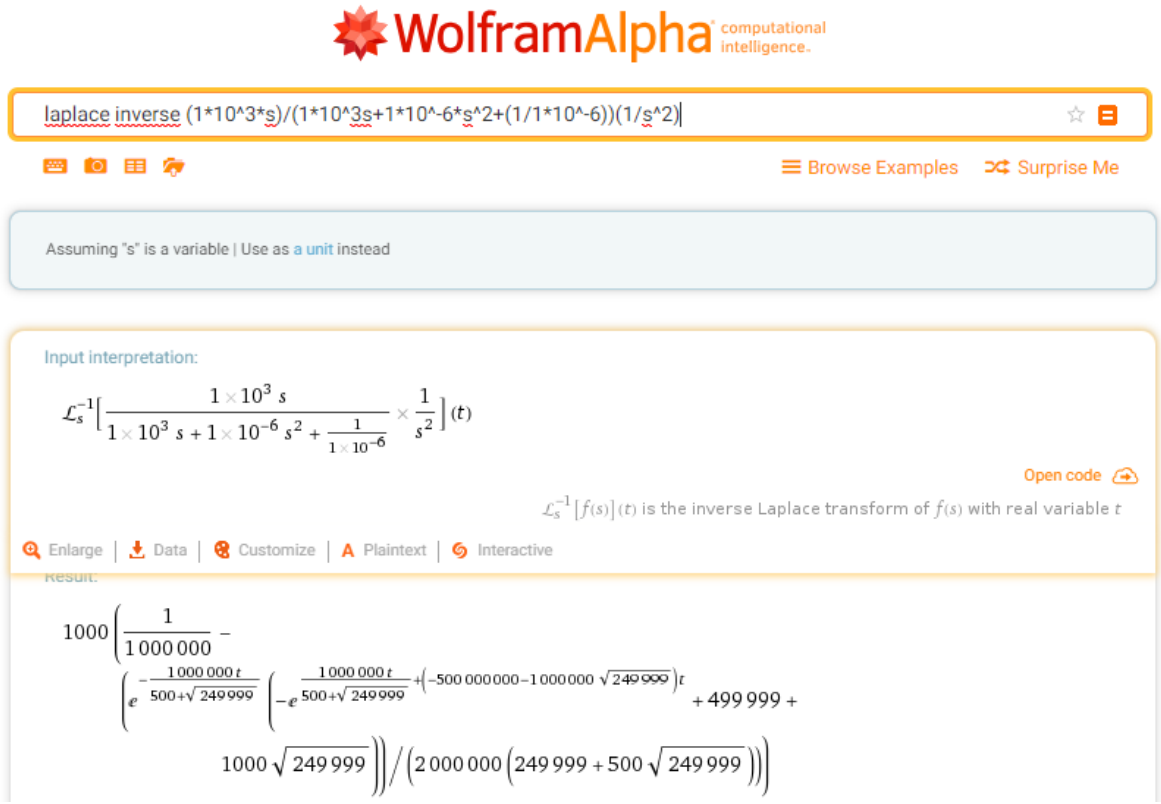


(t from -6.8×10^{-7} to 0.001)



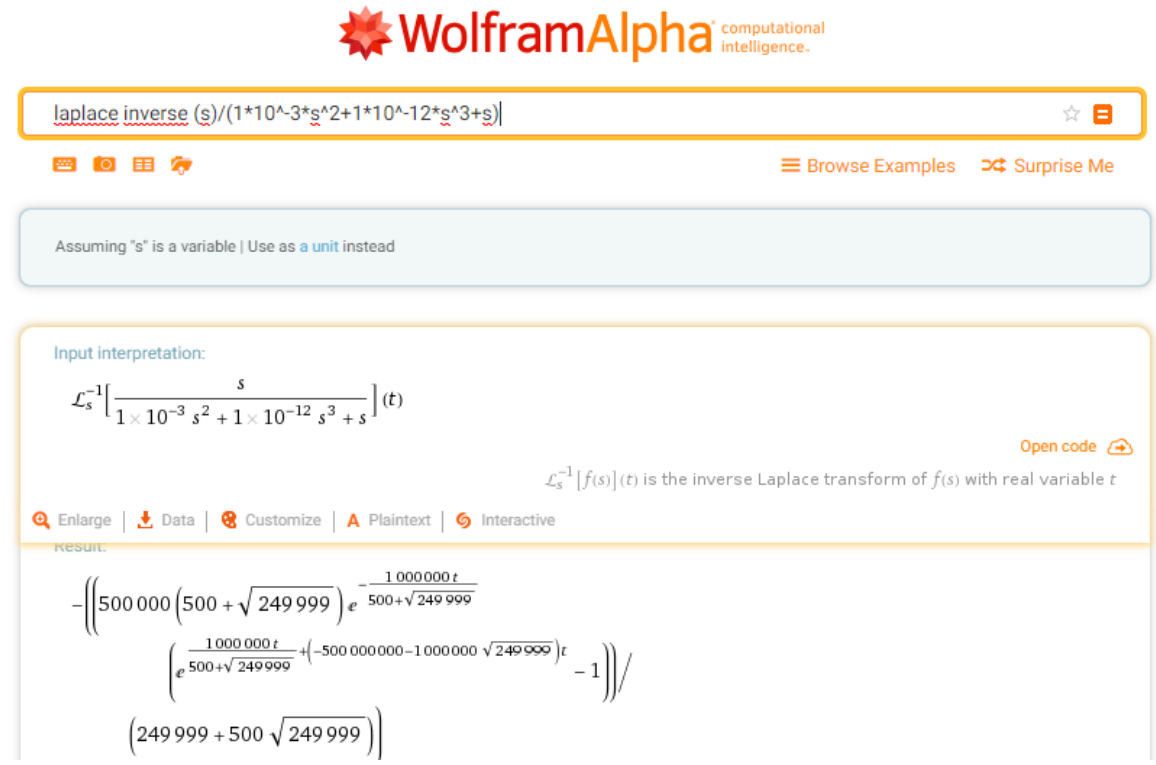
(t from -5.3×10^{-7} to 0.009)

- *Respuesta a rampa de la resistencia:*

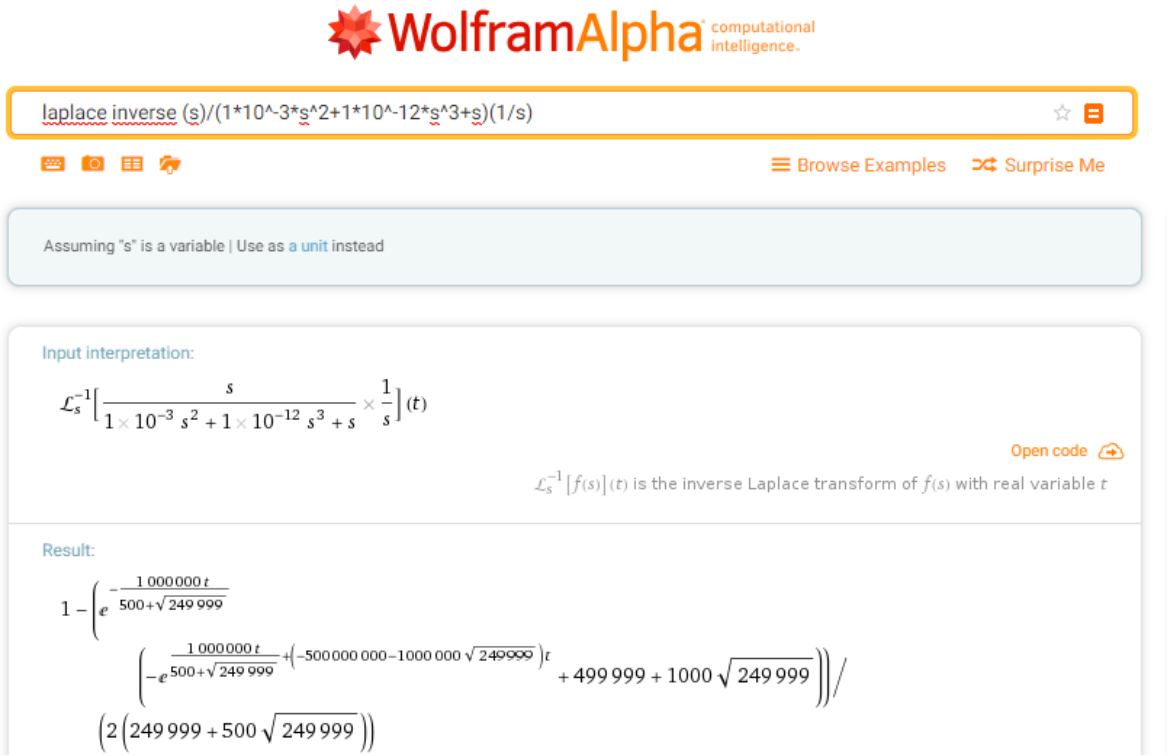


$$1000\left(\frac{1}{1\,000\,000}-\left(e^{-\frac{1\,000\,000\,t}{500+\sqrt{249\,999}}}\left(-e^{\frac{1\,000\,000\,t}{500+\sqrt{249\,999}}+\left(-500\,000\,000-1\,000\,000\sqrt{249\,999}\right)t}+499\,999+1000\sqrt{249\,999}\right)\right)\Big/\left(2\,000\,000\left(249\,999+500\sqrt{249\,999}\right)\right)\right)$$

- *Respuesta a impulso del capacitor:*



- *Respuesta a escalón unitario del capacitor:*



- *Respuesta a rampa del capacitor:*