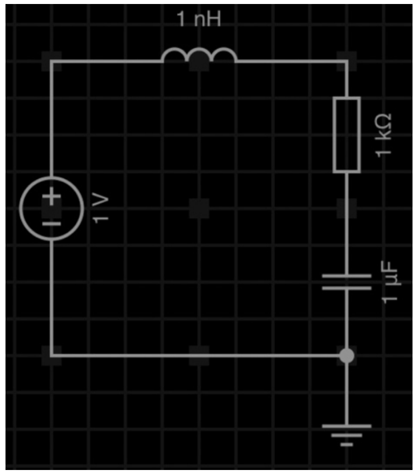
Análisis de sistemas lineales
Martha Hernández Jara
Tarea #4

Circuito RLC:




El circuito mostrado anteriormente tiene tres componentes los cuales se les calculará las funciones de transmisión para cada voltaje de salida ante entradas de señales de impulso, escalón y rampa.

FORMULAS:

- Inductor

Tiempo:

$$V_L = L\frac{di}{dt}$$

Frecuencia:

$$V_L = L * S * I_{(S)}$$

- Capacitor

Tiempo:

$$V_C = \frac{1}{C}\int_0^T I_C \, dt$$

Frecuencia:

$$V_C = \frac{I_{(S)}}{C * S}$$

- Resistencia

Tiempo:

$$V_R = I * R$$

Frecuencia:

$$V_R = I_{(S)} * R$$

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Aplicando las Leyes de Kirchhoff en el circuito, obtenemos:

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

Sustituyendo y aplicando Laplace,  se obtiene la formula de cada componente:

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

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

Luego utilizando WolframAlpha se obtienen los resultados de cada componente según sus entradas de señales.

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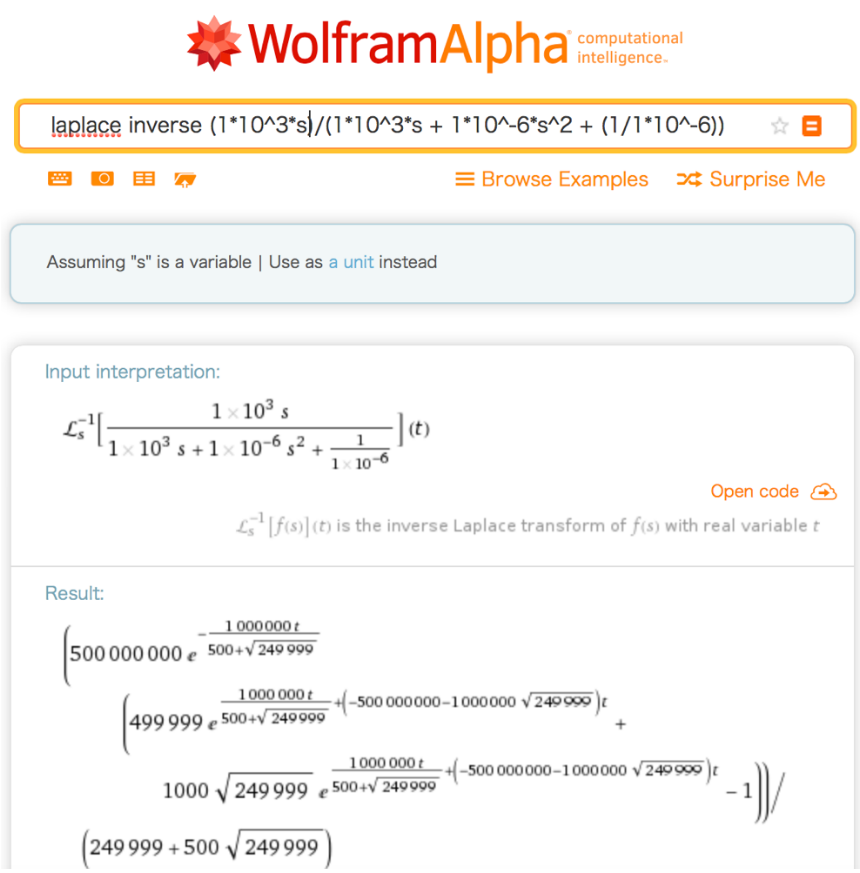
- Resistencia

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

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

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

Impulso:



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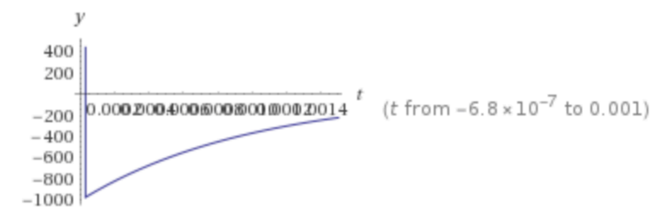
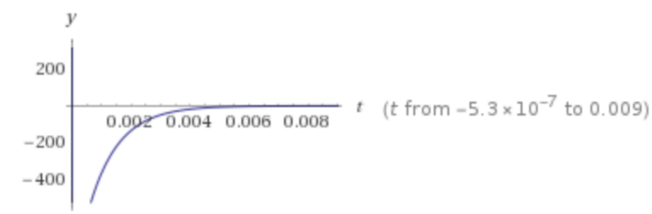
Plots:




Escalón:

WolframAlpha computational intelligence.

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

Browse Examples    Surprise Me

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

Input interpretation:

$$\mathcal{L}_s^{-1}\left[\frac{1\times 10^3\, s}{1\times 10^3\, s+1\times 10^{-6}\, s^2+\frac{1}{1\times 10^{-6}}}\times\frac{1}{s}\right](t)$$

Open code

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

Result:

$$-\left(\left(500\left(500+\sqrt{249999}\right)e^{-\frac{1000000\,t}{500+\sqrt{249999}}}\left(e^{\frac{1000000\,t}{500+\sqrt{249999}}+\left(-500000000-1000000\sqrt{249999}\right)t}-1\right)\right)\Big/\left(249999+500\sqrt{249999}\right)\right)$$

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Rampa:

WolframAlpha computational intelligence.

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

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

Input interpretation:

$$\mathcal{L}_s^{-1}\left[\frac{1\times 10^3\, s}{1\times 10^3\, s + 1\times 10^{-6}\, s^2 + \frac{1}{1\times 10^{-6}}}\times\frac{1}{s^2}\right](t)$$

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

Result:

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

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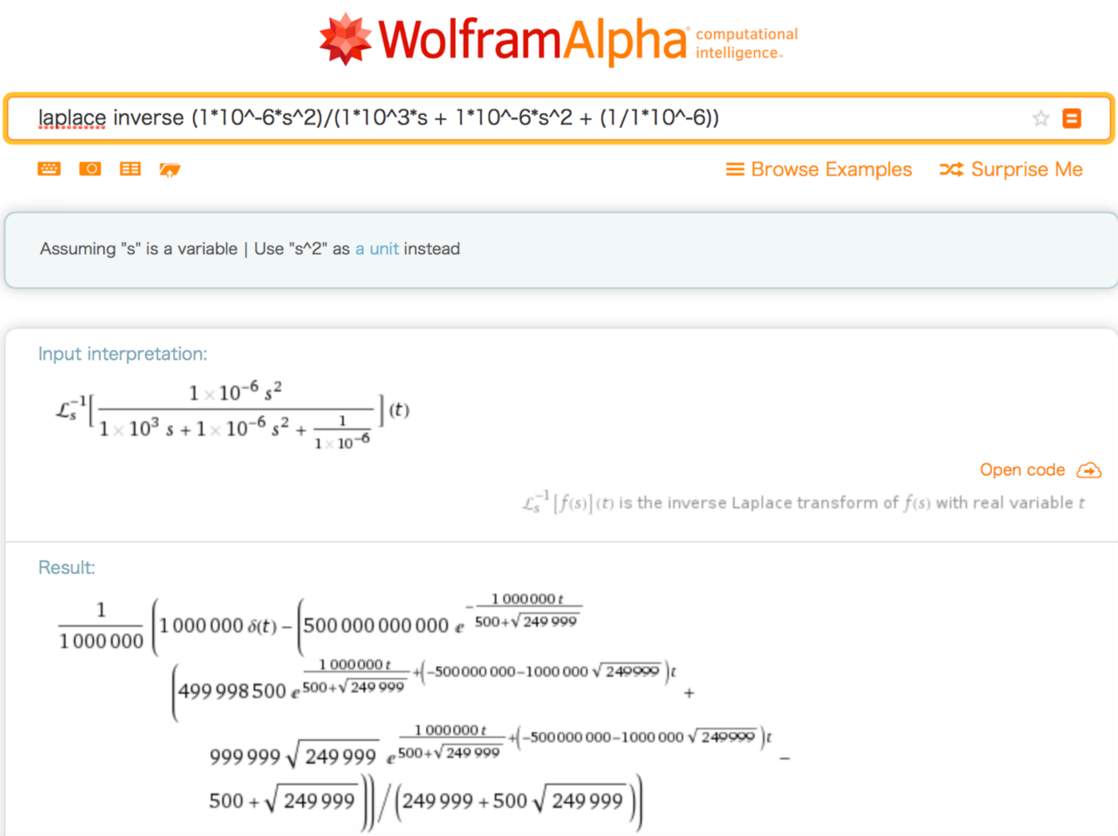
- Inductor

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

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

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

Impulso:



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Escalón:

WolframAlpha computational intelligence.

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

Browse Examples   Surprise Me

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

Input interpretation:

$$\mathcal{L}_s^{-1}\left[\frac{1\times 10^{-6}\, s^2}{1\times 10^3\, s + 1\times 10^{-6}\, s^2 + \frac{1}{1\times 10^{-6}}}\times\frac{1}{s}\right](t)$$

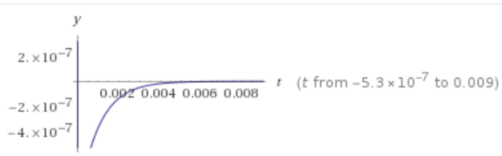
Open code

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

Result:

$$\left(e^{-\frac{1000000\, t}{500+\sqrt{249999}}}\left(499999\, e^{\frac{1000000\, t}{500+\sqrt{249999}}+\left(-500000000-1000000\sqrt{249999}\right)t} + 1000\sqrt{249999}\, e^{\frac{1000000\, t}{500+\sqrt{249999}}+\left(-500000000-1000000\sqrt{249999}\right)t} - 1\right)\right)\Big/\left(2\left(249999+500\sqrt{249999}\right)\right)$$

Plots:

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Rampa:

WolframAlpha computational intelligence.

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

Browse Examples   Surprise Me

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

Input interpretation:

$$\mathcal{L}_s^{-1}\left[\frac{1\times 10^{-6}\, s^2}{1\times 10^3\, s+1\times 10^{-6}\, s^2+\frac{1}{1\times 10^{-6}}}\times\frac{1}{s^2}\right](t)$$

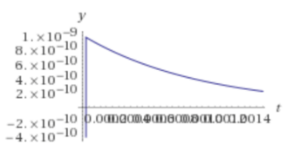
Open code

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

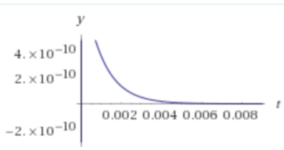
Result:

$$-\frac{(500+\sqrt{249999})\, e^{-\frac{1000000\, t}{500+\sqrt{249999}}}\left(e^{\frac{1000000\, t}{500+\sqrt{249999}}+(-500000000-1000000\sqrt{249999})t}-1\right)}{2000000\,(249999+500\sqrt{249999})}$$

Plots:




($t$ from $-7.3\times10^{-7}$ to 0.001)




($t$ from $-5.3\times10^{-7}$ to 0.009)

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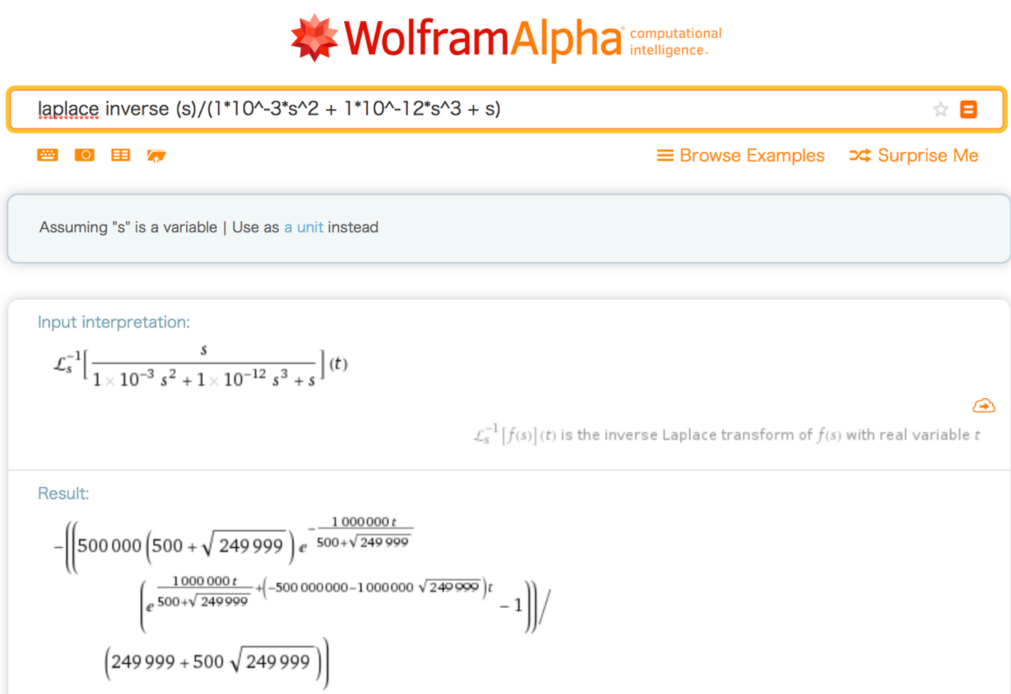
- Capacitor

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

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

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

Impulso:



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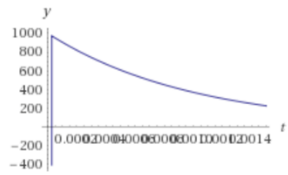
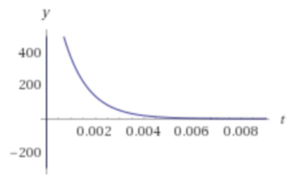
Plots:




($t$ from $-6.8\times10^{-7}$ to 0.001)




($t$ from $-5.3\times10^{-7}$ to 0.009)

Escalón:

WolframAlpha computational intelligence.

laplace inverse (s)/(1*10^-3*s^2 + 1*10^-12*s^3 + s) * 1/s

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

Input interpretation:

$$\mathcal{L}_s^{-1}\left[\frac{s}{1\times10^{-3}\,s^2+1\times10^{-12}\,s^3+s}\times\frac{1}{s}\right](t)$$

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

Result:

$$1-\left(e^{-\frac{1000000\,t}{500+\sqrt{249999}}}\left(-e^{\frac{1000000\,t}{500+\sqrt{249999}}+\left(-500000000-1000000\sqrt{249999}\right)t}+499999+1000\sqrt{249999}\right)\right)\Big/\left(2\left(249999+500\sqrt{249999}\right)\right)$$

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Rampa:

WolframAlpha computational intelligence.

laplace inverse (s)/(1*10^-3*s^2 + 1*10^-12*s^3 + s) * 1/s^2

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

Input interpretation:

$$\mathcal{L}_s^{-1}\left[\frac{s}{1\times 10^{-3}\, s^2 + 1\times 10^{-12}\, s^3 + s}\times\frac{1}{s^2}\right](t)$$

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

Result:

$$\left(e^{-\frac{1000000\,t}{500+\sqrt{249999}}}\left(-500\, e^{\frac{1000000\,t}{500+\sqrt{249999}}+\left(-500000000-1000000\sqrt{249999}\right)t} + \sqrt{249999}\, e^{\frac{1000000\,t}{500+\sqrt{249999}}+\left(-500000000-1000000\sqrt{249999}\right)t} + 499998500 + 999999\sqrt{249999}\right)\right) \Big/ \left(2000000\left(249999+500\sqrt{249999}\right)\right) + t - \frac{1}{1000}$$