National Institute of Technology, Gifu College
Electrical and Computer Engineering
by T.Tokoro

Ex.S3 Response of electric circuit when impulse response and input signal are shown as follows. Sinusoidal waves input. R=1Ω,L=1 H (Series connection)

$R := 1 \qquad L := 1 \qquad Z(s) := R + s \cdot L \qquad h(t) := e^{-t}$ impulse response

$h(t) := e^{-t} \xrightarrow{laplace} \frac{1}{s+1} \qquad H(s) := \frac{1}{s+1} \qquad R := 1 \quad \omega := 1 \quad L := 1$

$x(t) := \sin(t) + \sin(2 \cdot t) + \sin(3 \cdot t)$ *input_signal*

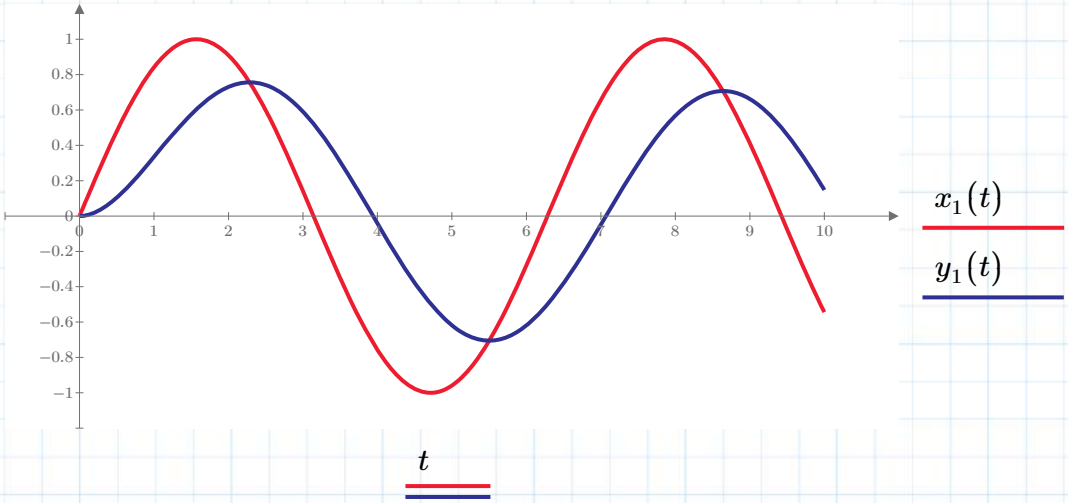
$x_1(t) := \sin(\omega \cdot t) \xrightarrow{laplace} \frac{1}{s^2+1} \qquad X_1(s) := \frac{1}{s^2+1}$

$Y_1(s) := X_1(s) \cdot H(s) \rightarrow \frac{1}{(s+1) \cdot (s^2+1)} \xrightarrow{invlaplace} \frac{e^{-t}}{2} - \frac{\cos(t)}{2} + \frac{\sin(t)}{2}$

$x_1(t) := \sin(\omega \cdot t)$

$y_1(t) := \frac{e^{-t}}{2} - \frac{\cos(t)}{2} + \frac{\sin(t)}{2}$

output_signal



$x_2(t) := \sin(2 \cdot \omega \cdot t) \xrightarrow{laplace} \frac{2}{s^2+4} \qquad X_2(s) := \frac{2}{s^2+4}$

$Y_2(s) := X_2(s) \cdot H(s) \rightarrow \frac{2}{(s+1) \cdot (s^2+4)} \xrightarrow{invlaplace} \frac{2 \cdot e^{-t}}{5} - \frac{2 \cdot \cos(2 \cdot t)}{5} + \frac{\sin(2 \cdot t)}{5}$

$x_2(t) := \sin(2 \cdot \omega \cdot t)$

$y_2(t) := \frac{2 \cdot e^{-t}}{5} - \frac{2 \cdot \cos(2 \cdot t)}{5} + \frac{\sin(2 \cdot t)}{5}$

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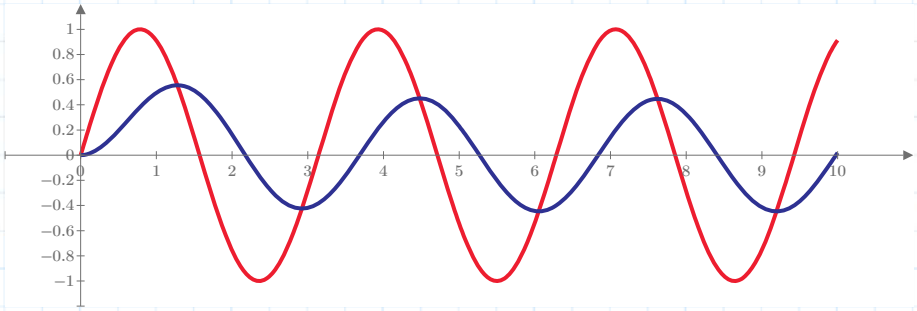


$x_2(t)$

$y_2(t)$

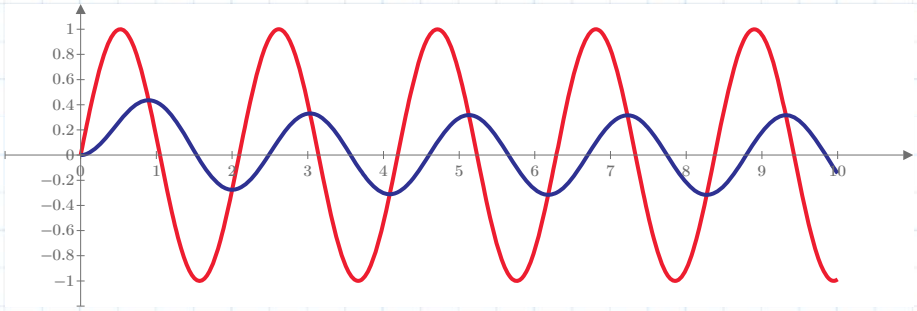
t

$x_3(t) := \sin(3 \cdot \omega \cdot t) \xrightarrow{laplace} \frac{3}{s^2+9}$ $\quad X_3(s) := \frac{3}{s^2+9}$

$Y_3(s) := X_3(s) \cdot H(s) \rightarrow \frac{3}{(s+1)\cdot(s^2+9)} \xrightarrow{invlaplace} \frac{3 \cdot e^{-t}}{10} - \frac{3 \cdot \cos(3 \cdot t)}{10} + \frac{\sin(3 \cdot t)}{10}$

$x_3(t) := \sin(3 \cdot \omega \cdot t)$

$y_3(t) := \frac{3 \cdot e^{-t}}{10} - \frac{3 \cdot \cos(3 \cdot t)}{10} + \frac{\sin(3 \cdot t)}{10}$

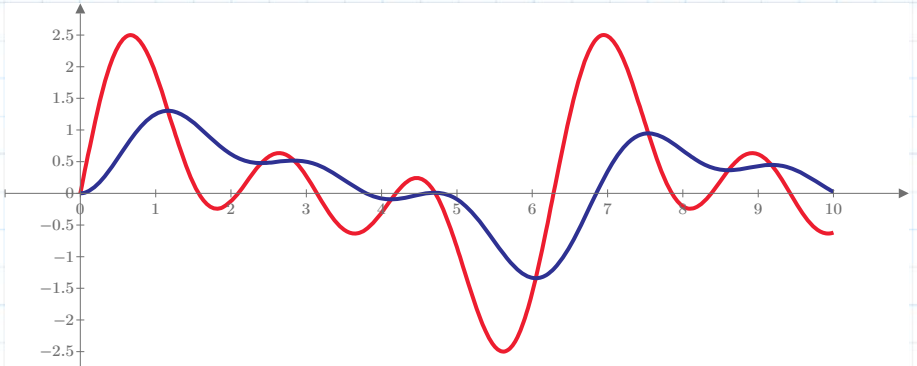


$x_3(t)$

$y_3(t)$

t

$x(t) := x_1(t) + x_2(t) + x_3(t)$ $\quad y(t) := y_1(t) + y_2(t) + y_3(t)$



input_signal

$x(t)$

$y(t)$

output_signal

t

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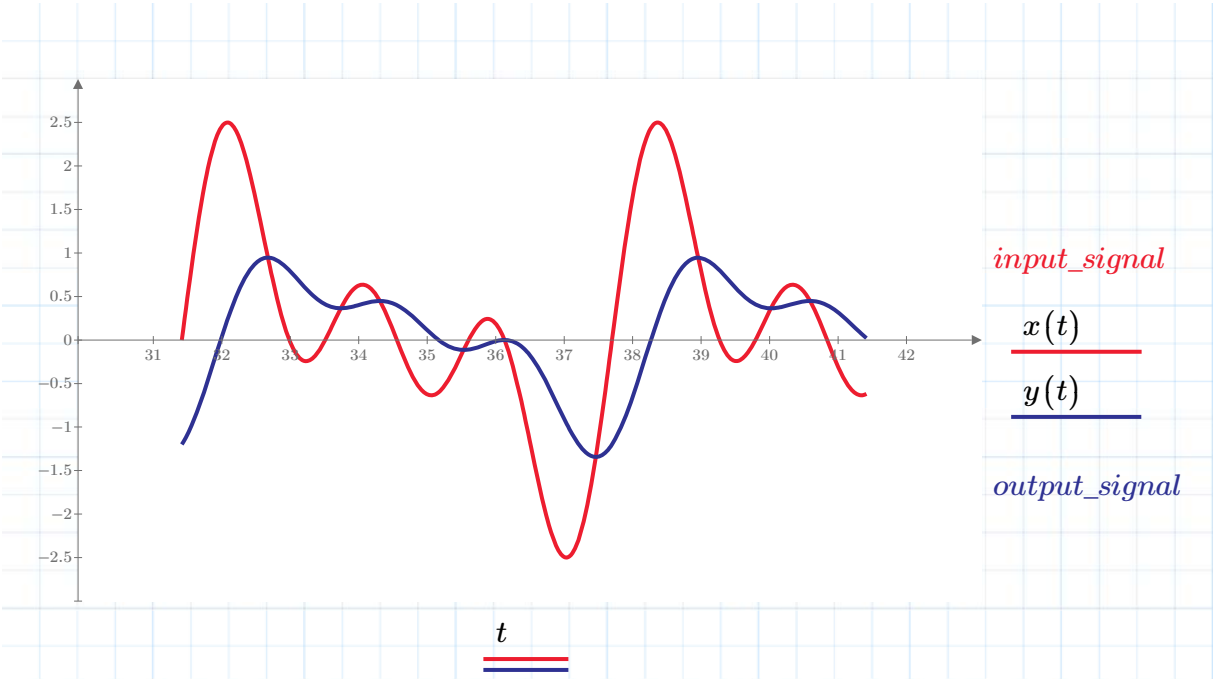

After only 5 cycles, the input and output signals are as same as Ex-s1 or Ex-s2.

$$H(\omega) := \frac{1}{1+\omega \cdot 1\mathrm{i}}$$

$$y_0(t) := |H(1)| \cdot \sin(t + \arg(H(1))) + |H(2)| \cdot \sin(2 \cdot t + \arg(H(2))) + |H(3)| \cdot \sin(3 \cdot t + \arg(H(3)))$$