EE49001: Control and Electronic System Design
Assignment-1

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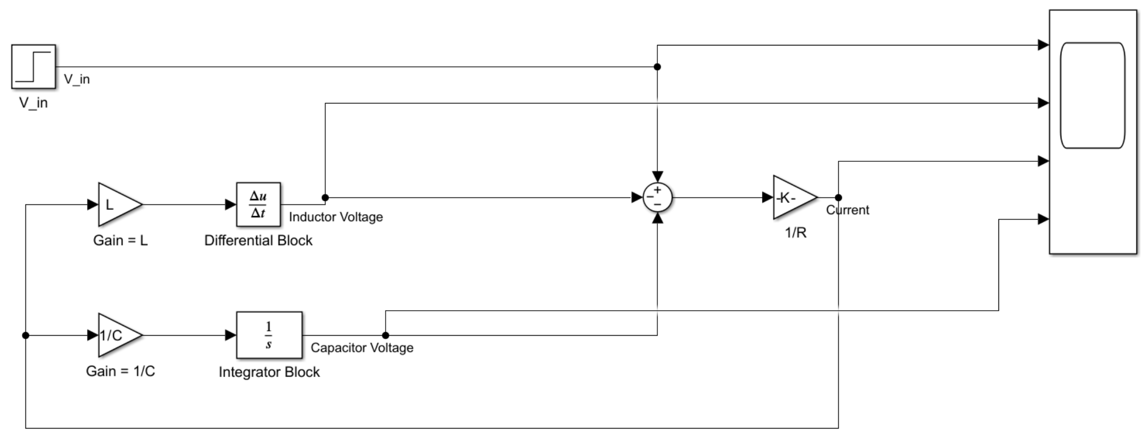
1. Representing an inductor as a block with TF of sL and a capacitor as a block with TF of $\frac{1}{sC}$, obtain a block diagram representation of a series RLC circuit excited by a voltage source $v(t)$.



The Transfer function: $G(s) = \frac{I(s)}{V(s)} = \frac{1}{R+sL+\frac{1}{sC}}$

The same transfer function $G(s)$ can be realised in two mathematically equivalent forms.

$$G(s) = \frac{\frac{1}{R}}{1+\frac{1}{R}\left(sL+\frac{1}{sC}\right)} = \frac{\frac{1}{sL}}{1+\frac{1}{sL}\left(R+\frac{1}{sC}\right)}$$

2. Using MATLAB-SIMULINK, obtain the voltage responses $v_L(t)$, $v_C(t)$ and the current $i(t)$ when $v(t)$ is the unit step input, $R = 40\ \Omega, L = 10\ mH, C = 1\mu F$

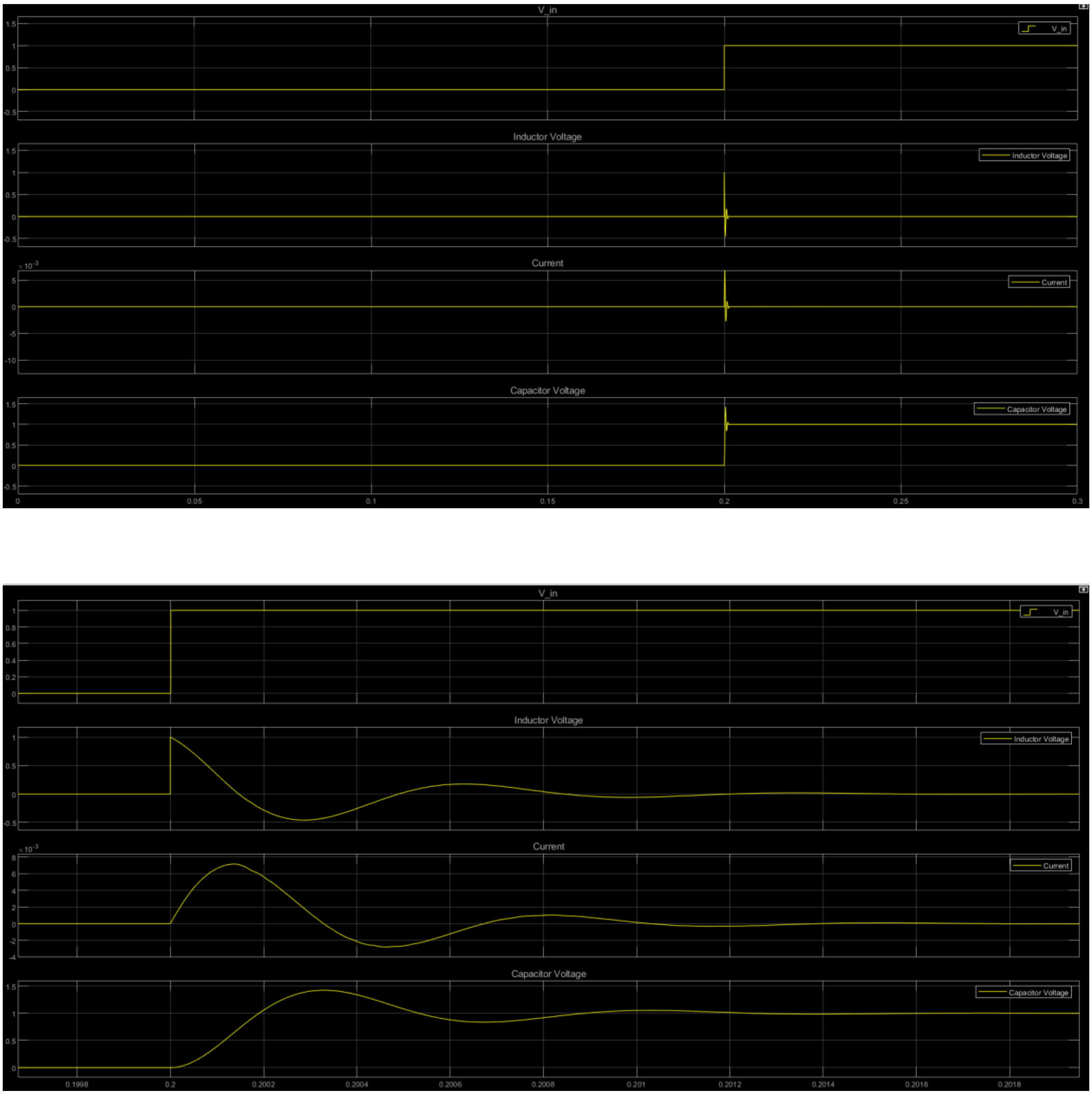


Fig: Simulink Plot for configuration-1

Here, we use the transfer function:

$$G(s) = \frac{\frac{1}{R}}{1 + \frac{1}{R}\left(sL + \frac{1}{sC}\right)}$$

3. Repeat the above considering the TF of inductor as $\frac{1}{sL}$ and capacitor as $\frac{1}{sC}$.

For this part of experiment, we are taking the inductor impedance as $\frac{1}{sL}$. Therefore, the transfer function $G(s) = \frac{I(s)}{V(s)}$ is given by:

$$G(s) = \frac{\frac{1}{sL}}{1 + \frac{1}{sL}\left(R + \frac{1}{sC}\right)}$$

For the given conditions, the MATLAB-Simulink Block Diagram is given as:

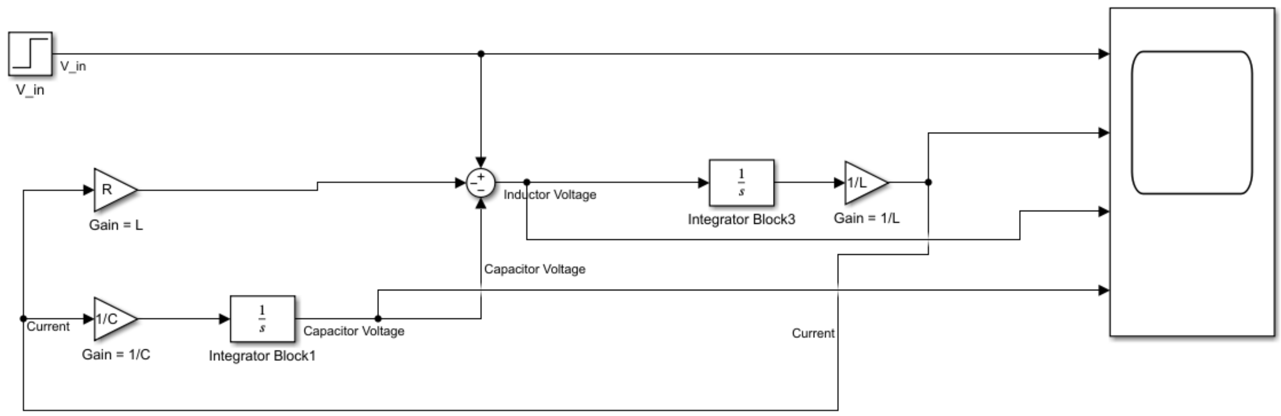


Fig. MATLAB-Simulink Block Diagram

On execution, we get the following waveform for $i(t), V_L(t)$ & $V_C(t)$

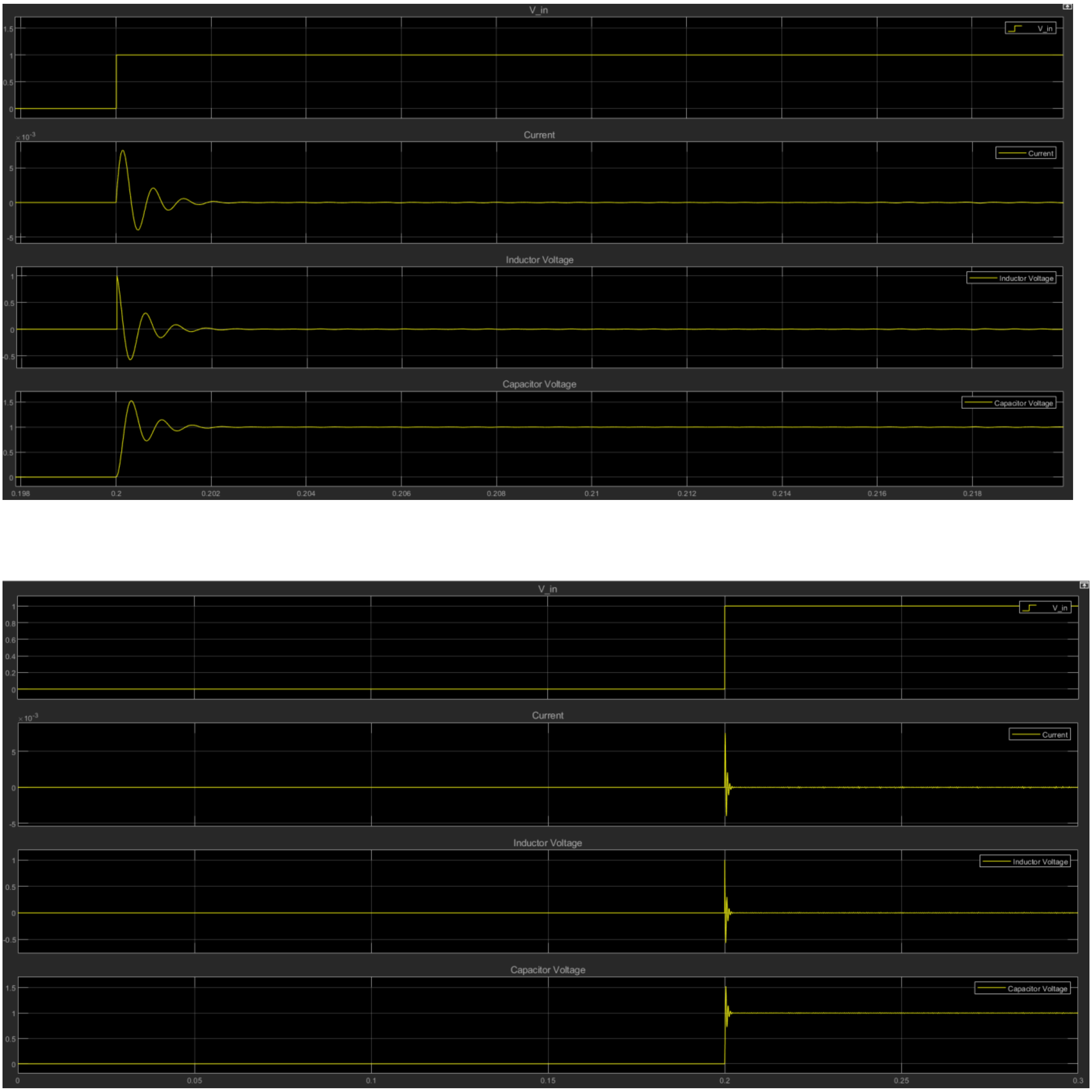


Fig. Plots for configuration-2

4. Are the responses obtained in (1) and (2) identical? If not, explain the reason behind the difference and explain which of the above representations is more appropriate.

	Response in Configuration-1	Response in Configuration-2
$i(t)$	Jump of 0.025 A at t=0, past t=0, a damped oscillation	Continuous at t=0 and then damped oscillation
V_L	At t=0, $V_L = 0$ and at $t = 0^+, V_L\ is\ a\ decreasing\ function$	Jump of 1 V at t=0 and later a damped oscillation
V_c	%overshoot is > 100% $V_{c,peak} > 2V_c(\infty)$	%overshoot is around 50% $V_{C,peak} \approx 1.5V_C$

Both the configurations show different behaviour, as sL is an improper transfer function, non-causal and hence, physically unrealizable. This is because, it involves a derivative. Since, the computation of derivatives needs information about the future. Also, derivative amplifies noise and distorts the output at input discontinuities. But this effect is removed in case of $\frac{1}{sL}$ as it's a proper transfer function and hence, more appropriate.