Prelab Problem 4.1: First-order RC and RL circuits

Consider the RC and RL circuits shown in Fig. 1. Each circuit is driven by a voltage signal source $v_S(t)$ with a source resistance (i.e., Thevenin resistance) $R_S = 50\ \Omega$.

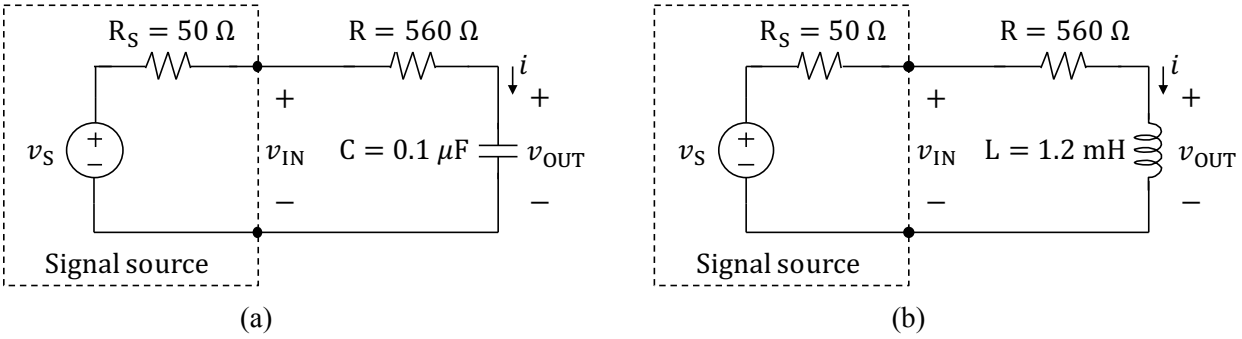

Fig. 1. (a) RC circuit, and (b) RL circuit.

(a) What is the time constant associated with the RC circuit?

(b) For the RC circuit, if the voltage signal source is set up to produce a unit step, i.e., $v_S(t) = 1\text{V} \cdot u(t)$, determine $v_{OUT}(t)$ and $v_{IN}(t)$ for time $t > 0$. Hint: what are $v_{OUT}(0^+)$ and $v_{OUT}(t \to \infty)$, and to find $v_{IN}(t)$ consider $i(t)$.

(c) What is the time constant associated with the RL circuit?

(d) For the RL circuit, if the voltage signal source is set up to produce a unit step, i.e., $v_S(t) = 1\text{V} \cdot u(t)$, determine $v_{OUT}(t)$ and $v_{IN}(t)$. Hint: what are $v_{OUT}(0^+)$ and $v_{OUT}(t \to \infty)$, and to find $v_{IN}(t)$ consider $i(t)$.

Prelab Problem 4.2: Second-order RLC circuit

Consider the parallel RLC circuit shown in Fig. 2, which is driven by a voltage signal source $v_S(t)$ with a source resistance $R_S = 50\ \Omega$.

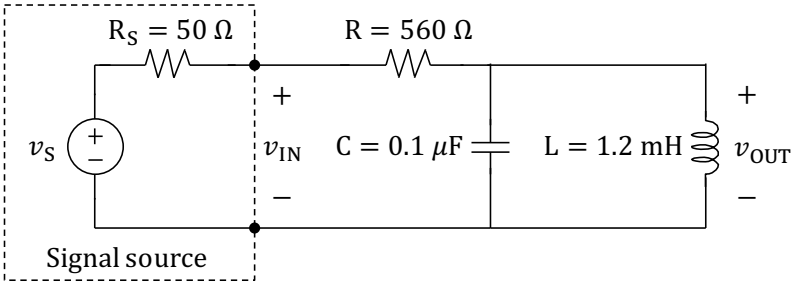

Fig. 2. Parallel RLC circuit.

(a) What is the equivalent parallel resistance in this RLC circuit?

(b) Calculate the damping factor α and the undamped natural radial frequency ω_0 for this circuit, and determine the type of response (under damped, over damped, or critically damped) which $v_{\mathrm{OUT}}(t)$ will have?

(c) If the circuit is under damped, calculate the damped natural radial frequency ω_{d} and the period of oscillation T.

(d) If the voltage signal source is set up to produce a unit step, i.e., $v_{\mathrm{S}}(t) = 1\mathrm{V} \cdot u(t)$, determine $v_{\mathrm{OUT}}(t)$ for time $t > 0$.