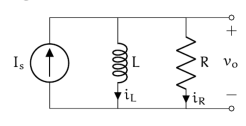
can.exe Exercises for Chapter can

Exercise can.mad

Use the diagram below to answer the following questions and imperatives. Let $I_s = A_0$, where $A_0 \in \mathbb{R}$ is a known constant. Perform a full circuit analysis, including the transient response. The initial inductor current is $i_L(0) = 0$.

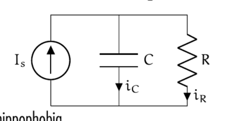
(a) Write the elemental, KCL, and KVL equations.
(b) Write the differential equation for $i_L(t)$ arranged in the standard form and identify the time constant τ.
(c) Solve the differential equation for $i_L(t)$ and use the solution to find the output voltage $v_o(t)$.



Exercise can.theocratically

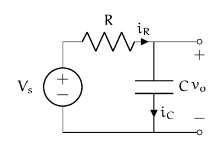
Use the diagram below to answer the following questions and imperatives. Let $I_s = A_0$, where $A_0 \in \mathbb{R}$ is a known constant. Perform a full circuit analysis, including the transient response. The initial capacitor voltage is $v_C(0) = v_{C0}$, a known constant.

(a) Write the elemental, KCL, and KVL equations.
(b) Write the differential equation for $v_C(t)$ arranged in the standard form.
(c) Solve the differential equation for $v_C(t)$.



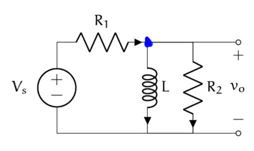
Exercise can.hippophobia

For the RC circuit diagram below, perform a complete circuit analysis to solve for $v_o(t)$ if $V_S(t) = A \sin \omega t$, where $A \in \mathbb{R}$ is a given amplitude and $\omega \in \mathbb{R}$ is a given angular frequency. Let $v_C(t)|_{t=0} = v_{C0}$, where $v_{C0} \in \mathbb{R}$ is a given initial capacitor voltage. Hint: you will need to solve a differential equation for $v_C(t)$.



Exercise can.fruitarianism

For the circuit diagram below, perform a complete circuit analysis to solve for $v_o(t)$ if $V_s(t) = A \sin \omega t$, where $A \in \mathbb{R}$ is a given amplitude and $\omega \in \mathbb{R}$ is a given angular frequency. Let $i_L(t)|_{t=0} = 0$ be the initial inductor current. Hint: you will need to solve a differential equation for $i_L(t)$.



$V_{R_1} = R_1 i_{R_1}$ $\quad$ $V_{R_2} = R_2 i_{R_2}$

$$\frac{di_L}{dt} = \frac{1}{L} V_L = \frac{1}{L} V_{R_2} = \frac{1}{L} R_2 i_{R_2} = \frac{R_2}{L}(i_{R_1} - i_L)$$

$i_{R_1} - i_L - i_{R_2} = 0$ $\quad$ $V_L = V_{R_2}$ $\quad$ $\frac{di_L}{dt} L = V_L$

$i_{R_2} = i_{R_1} - i_L$

$$\frac{di_L}{dt} = \frac{1}{L}(V_s - V_{R_1}) = \frac{1}{L}(V_s - R_1 i_{R_1}) = \frac{1}{L}(V_s - R_1(i_L + i_{R_2})) = \frac{1}{L}\left(V_s - R_1\left(i_L + \frac{V_{R_2}}{R_2}\right)\right)$$

$$= \frac{1}{L}\left(V_s - R_1\left(i_L + \frac{V_L}{R_2}\right)\right)$$

$$\frac{di_L}{dt} = \frac{1}{L}\left(V_s - R_1\left(i_L + \frac{L}{R_2}\frac{di_L}{dt}\right)\right)$$

$$= \frac{V_s}{L} - \frac{R_1}{L} i_L + \frac{R_1}{R_2}\frac{di_L}{dt}$$

$$\frac{di_L}{dt}\left(1 - \frac{R_1}{R_2}\right) = \frac{V_s}{L} - \frac{R_1}{L} i_L$$

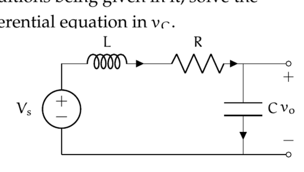
$$\frac{di_L}{dt} = \frac{V_s}{L\left(1 - \frac{R_1}{R_2}\right)} - \frac{R_1}{L\left(1 - \frac{R}{R_2}\right)} i_L$$

$$= \frac{1}{L\left(1 - \frac{R_1}{R_2}\right)}(V_s - R_1 i_L)$$

$$\boxed{\frac{di_L}{dt} = \frac{R_2}{L(R_2 - R_1)}(V_s - R_1 i_L)}$$

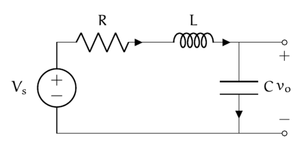
Exercise can.gastrolobium

For the circuit diagram below, perform a complete circuit analysis to solve for $v_o(t)$ if $V_s(t) = 0$. Let $v_C(t)|_{t=0} = 5$ V and $dv_C/dt|_{t=0} = 0$ V/s be the initial conditions. Assume the characteristic equation has distinct roots. Recommendation: due to the initial conditions being given in it, solve the differential equation in v_C.



Exercise can.thyroprivic

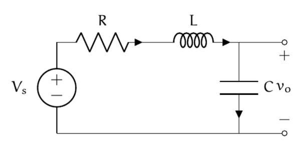
For the circuit diagram below, perform a complete circuit analysis to solve for $v_o(t)$ if $V_s(t) = 3 \sin(10t)$. Let $v_C(t)|_{t=0} = 0$ V and $dv_C/dt|_{t=0} = 0$ V/s be the initial conditions. Assume the characteristic equation has distinct, complex roots. Recommendation: due to the initial conditions being given in it, solve the differential equation in v_C. Also, consider which, if any, of your results from Exercise can. apply and re-use them, if so.



Exercise can.hemogenesis

For the circuit diagram below, solve for $v_o(t)$ if $V_s(t) = A \sin \omega t$, where $A = 2$ V is the given amplitude and $\omega \in \mathbb{R}$ is a given angular frequency. Let $R = 50\ \Omega$, $L = 50$ mH, and $C = 200$ nF. Let the circuit have initial conditions $v_C(0) = 1$ V and $i_L(0) = 0$ A. Find the steady-state ratio of the output amplitude to the input amplitude A for $\omega = \{5000, 10000, 50000\}$ rad/s. This circuit is called a low-pass filter—explain why this makes sense. Plot $v_o(t)$ in MATLAB, Python, or Mathematica for $\omega = 400$ rad/s (you think this won't be part of the quiz, but it will be!). Hint: either re-write your system of differential-algebraic equations and initial conditions as a single second-order differential equation with initial conditions in the differential variable or re-write it as a system of two first-order differential equations and solve that.

low−pass filter



Exercise can.photochromascope

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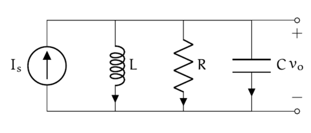
Use the circuit diagram below to answer the following questions and imperatives. Let $I_s = A_0$, where $A_0 > 0$ is a known constant. Perform a full circuit analysis, including the transient response. The initial inductor current is $i_L(0) = 0$ and the initial capacitor voltage is $v_C(0) = 0$. Assume the damping ratio $\zeta \in (0, 1)$; i.e. the system is underdamped and the roots of the characteristic equation are complex.

(a) Write the elemental, KCL, and KVL equations.
(b) Write the second-order differential equation for $i_L(t)$ arranged in the standard form and identify the natural frequency ω_n and damping ratio ζ.
(c) Convert the initial condition in v_C to a second initial condition in i_L.
(d) Solve the differential equation for $i_L(t)$ and use the solution to find the output voltage $v_o(t)$. It is acceptable to use a known solution and to express your solution in terms of ω_n and ζ.



ssan Steady−state circuit analysis

Steady-state circuit analysis does not require the, at times, lengthy process of solving differential equations. Impedance methods, presented in this chapter, are shortcuts to steady-state analysis. It is important to note that impedance methods do not give information about the transient response.