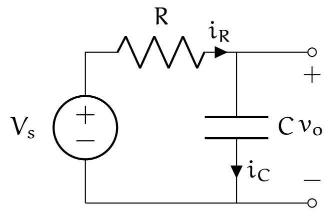
03.5 ssan.exe Exercises for Chapter 03 ssan

Exercise 03.1 roup

For the RC circuit diagram below, perform a circuit analysis to solve for the steady state voltage $v_o(t)$ 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. Use a *sine* phasor in the problem. Write your answer as a single sine phasor in *polar* form. Evaluate your answer for the following two sets of parameters.

$$A = 2, 5 \text{ V}$$
$$\omega = 10 \times 10^3, 20 \times 10^3 \text{ rad/s}$$
$$R = 100, 1000\ \Omega$$
$$C = 100, 10 \text{ nF}.$$

The first set should yield $v_o = 1.99e^{-j0.0997}$.

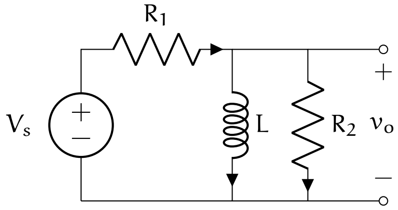


Exercise 03.2 vestmental

For the circuit diagram below, perform a complete circuit analysis to solve for the steady state voltage $v_o(t)$ 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. Use a *sine* phasor in the problem. Write your answer as a single sine phasor in *polar* form. Evaluate your answer for the following two sets of parameters.

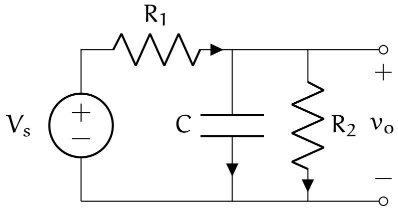
$$A = 3, 8 \text{ V}$$
$$\omega = 30 \times 10^3, 60 \times 10^3 \text{ rad/s}$$
$$R_1 = 100, 1000\ \Omega$$
$$R_2 = 1000, 100\ \Omega$$
$$L = 10, 100 \text{ mH}.$$

The first set should yield $v_o = 2.61e^{j0.294}$.



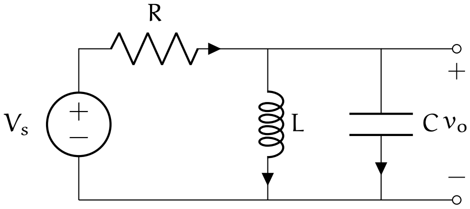
Exercise 03.3 beluga

For the circuit diagram below, solve for the steady state voltage $v_o(t)$ if $V_s(t) = Ae^{j\phi}$, where $A \in \mathbb{R}$ is a given input amplitude and $\phi \in \mathbb{R}$ is a given input phase. Write your answer as a single phasor in *polar* form (you may use intermediate variables in this final form as long as they're clearly stated).



Exercise 03.4 overparticular

For the circuit diagram below, solve for the steady state output voltage $v_o(t)$ if $V_S(t) = A\cos(\omega t)$. *Do* write V_S and the impedance of each element in phasor/polar form. *Do not* substitute V_S or the impedance of each element into your expression for $v_o(t)$. Recommendation: use a divider rule.

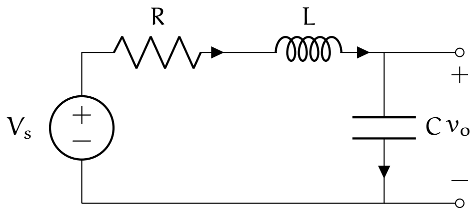


Exercise 03.5 radiomicrometer

For the circuit diagram below, solve for the steady state output voltage $v_o(t)$ if $V_s(t) = 3\sin(10t)$. Use a *sine* phasor in the problem. Write your answer as a single sine phasor in *polar* form. Evaluate your answer for the following two sets of parameters.

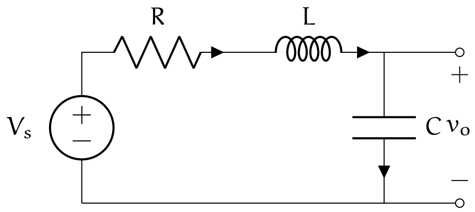
$$R = 10, 10^6\ \Omega$$
$$L = 500, 50\ \text{mH}$$
$$C = 100, 10\ \mu\text{F}.$$

The first set should yield $v_o = 3.01e^{-j0.0100}$.



Exercise 03.6 melodic

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. Find the steady-state ratio of the output amplitude to the input amplitude A for $\omega = \{5000, 10000, 50000\}$ rad/s. Plot the steady-state ratio as a function of ω in MATLAB, Python, or Mathematica. This circuit is called a **low-pass filter**—explain why this makes sense. Note that using impedance methods for steady state analysis makes this problem much easier than the transient analysis of this circuit in Exercise 02.6 can..



Exercise 03.7 entitatively

For the circuit diagram below, perform a circuit analysis to solve for the steady state voltage $v_o(t)$ if $I_S = Ae^{j0}$, where $A > 0$ is a given amplitude. Identify all impedance values in the circuit, but express your answer in terms of impedances (i.e. don't substitute for them in your final expression).

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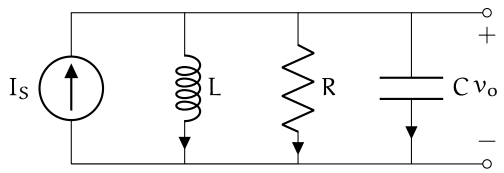

Exercise 03.8 abbey

For the circuit diagram below, perform a complete circuit analysis to solve for the steady state voltage $v_o(t)$ if $V_s(t) = Ae^{j\phi}$, where $A \in \mathbb{R}$ is a given input amplitude and $\phi \in \mathbb{R}$ is a given input phase. Write your answer as a single phasor in *polar* form. *Hint:* consider using a divider rule, but be wary of the parallel impedances for R_2 and L!

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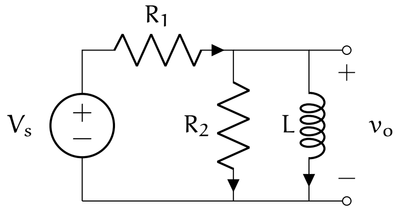

04 nlnmul

Nonlinear and multiport circuit elements

Thus far, we have considered only *one-port*, *linear* circuit elements. One-port elements have two terminals. Linear elements have voltage-current relationships that can be described by linear algebraic or differential equations.

Multi-port elements are those that have more than one port. In this chapter, we will consider several multi-port elements: transformers (two-port), transistors (two-port), and opamps (four-port).

Nonlinear elements have voltage-current relationships that cannot be described by a linear algebraic or differential equations. The convenient impedance methods of Chapter 03 ssan apply only to linear circuits, so we must return to the differential equation-based analysis of Chapter 02 can. In this chapter, we will consider several nonlinear circuits containing three different classes of nonlinear elements: diodes, transistors, and opamps.

A great number of the most useful circuits today include multi-port and nonlinear elements. Tasks such as ac-dc conversion, switching, amplification, and isolation require these elements.

We explore only the fundamentals of each element considered and present basic analytic techniques, but further exploration in Horowitz **and** Hill (2015), Agarwal **and** Lang (2005), and

Ulaby, Maharbiz **and** Furse (2018) is encouraged.