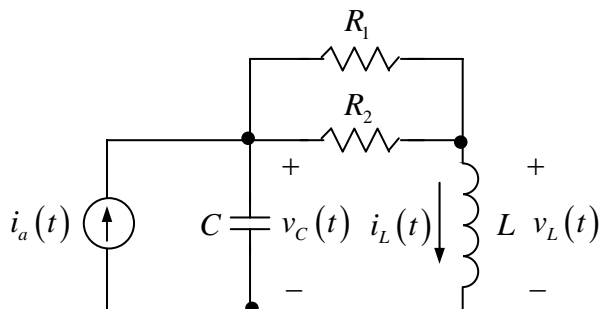


Lesson 06

Problem 6.1

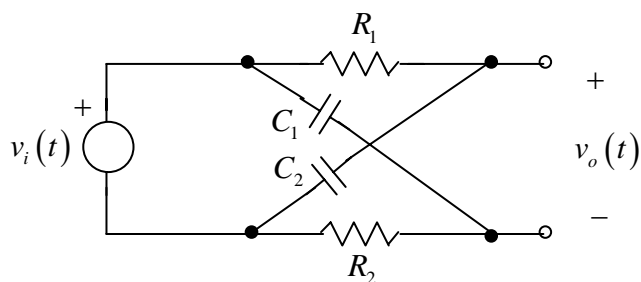
Consider the electrical system shown, with the applied current $i_a(t)$ as the input. Determine

- The differential equation relating the voltage $v_L(t)$ to the input current $i_a(t)$.
- The transfer function $V_L(s)/I_a(s)$.
- The transfer function between the inductor current and the input current $I_L(s)/I_a(s)$.
- The transfer function between the voltage across the capacitor and the input current $V_C(s)/I_a(s)$.



Problem 6.2

- Determine a single differential equation relating the output $v_o(t)$ and the input $v_i(t)$.
- Determine the transfer function relating the output voltage $V_o(s)$ to the input voltage $V_i(s)$.
- Determine the transfer function relating the current through resistor R_2 to the input voltage. Be sure to show your assumed reference direction for current in your solution.

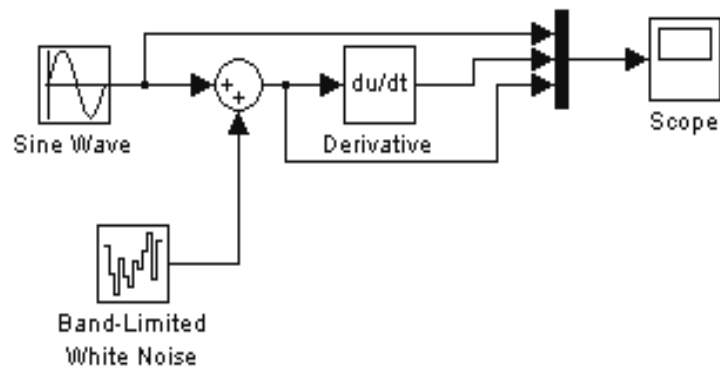


more...

Problem 6.3

To illustrate the problems involved with differentiation of signals, implement the following simulation diagram in Simulink. This system uses a sine wave for the input, adds noise to the sine wave, and then computes the derivative of the noisy sine wave. The noise is added using a *band-limited white noise* block (located in the *Source* library). The tall bar just before the scope is a *mux* (located in the *Signals and systems* library), and it allows the scope to plot the input sine wave, the noisy sine wave, and the estimated derivative of the noisy sine wave on a single plot.

Set the sine wave to have an amplitude of 1 at a frequency of 1 radian/sec. In the band-limited white noise, set the sample time to 0.05 (under the *mask parameters*).



- In the bandlimited white noise (under the *mask parameters*), set the noise power to 0. This means there is no added noise. Run the simulation. Verify that the simulation is computing the derivative of the input.
- In the bandlimited white noise (under the *mask parameters*), set the noise power to 0.0001. This adds a small amount of noise to the input sine wave, as you will see when you run the simulation. With this small amount of noise, what happens to the estimate of the derivative?
- Change the noise power to 0.001 and run the simulation. What does the derivative look like?

Turn in copies of your Simulink plots supporting your answers to parts a, b, c.