EE2015 Electric Circuits and Networks - Tutorial 4

August 30 and September 3, 2019

1. Using time-domain methods, find the natural and forced response.

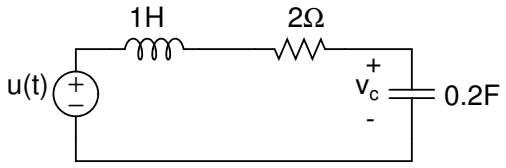
$$\frac{dy}{dt} + 3y(t) = 2e^{-2t}u(t), \quad y(0^+) = 1$$

2. Find the zero-state and zero-input response for the following system for $t \geq 0$. Solve it in the Laplace domain.

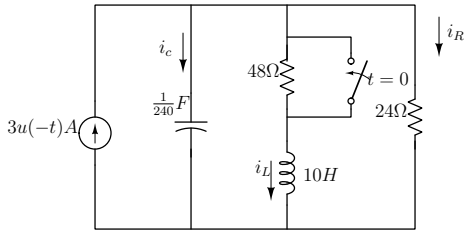
$$\frac{dy}{dt} + 2y(t) = x(t) + 2x(t-1)$$

$$x(t) = 4u(t), \quad y(0^-) = 2$$

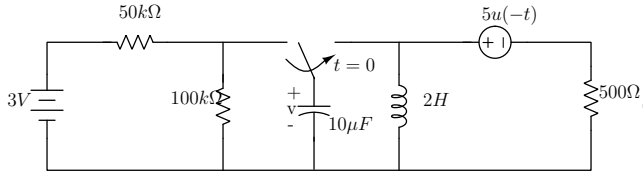
3. For the circuit shown below, find the step and impulse response using Laplace transform techniques. The output is $v_c(t)$.



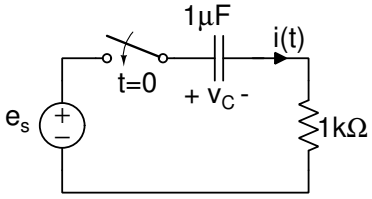
4. After being open for a long time, the switch in the network closes at $t = 0$. Find (a) $i_L(o^-)$ (b) $v_C(0^-)$ (c) $i_R(0^+)$ (d)$i_C(0^+)$ and (e) $v_C(0.2)$.



5. The switch is in the left position for a long time and is moved to the right at $t = 0$. Find (a) $\frac{dv}{dt}$ at $t = 0^+$, (b) v at 1ms and (c) the first value of $t > 0$ at which $v = 0$.

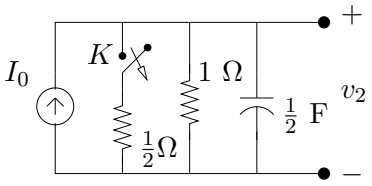


6. In the circuit shown below $v_c(0^-) = 1V$ and $e_s(t) = e^{-2t}$ V is applied at $t = 0$. The output is $i(t)$. Find (a) the natural and forced response of the circuit and (b) zero state and zero input response using time domain techniques.

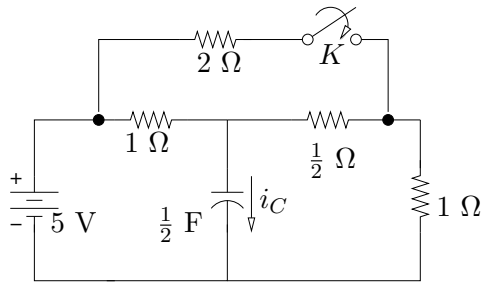


For the following questions, use Laplace transform techniques to solve for the network

7. The network shown below consists of a constant current source of value I_0, two resistors and a capacitor. At $t = 0$, the switch K is opened. For the element values given on the figure, determine $v_2(t)$ for $t \geq 0$.

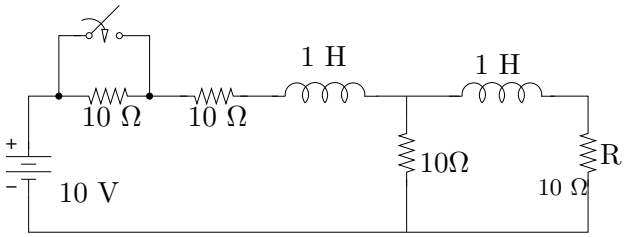


8. The network shown in the figure is in a steady state with the switch K open. At $t = 0$, the switch is closed. Find the current in the capacitor $i_C(t)$ for $t > 0$, sketch this waveform and determine the time constant.



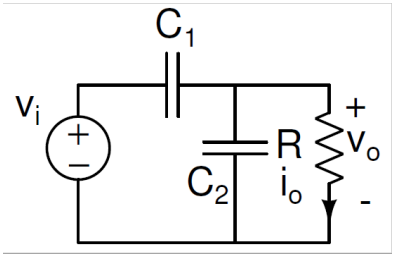
9. For the network shown below which is initially in steady-state, at time $t = 0$ the

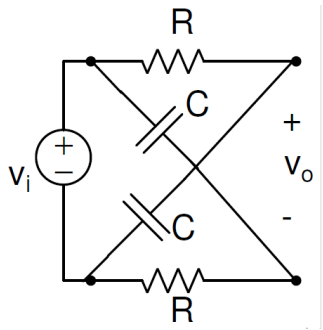
switch shorts the 10 Ω resistance. Find the current through the resistor R for $t \geq 0$ and sketch it.

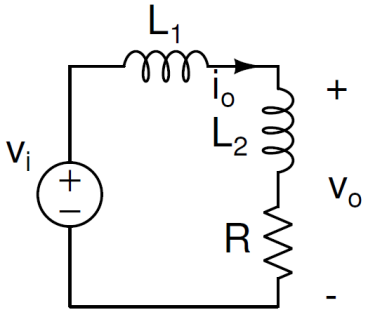


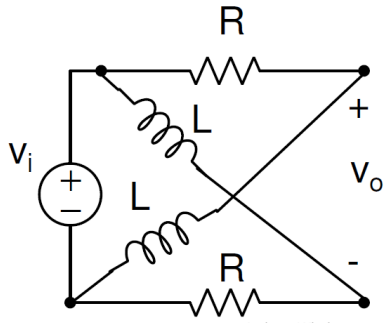
10. Evaluate and sketch the step response for the following circuits using time domain techniques. Write the differential equation and find the natural and forced response. Initial conditions are zero.

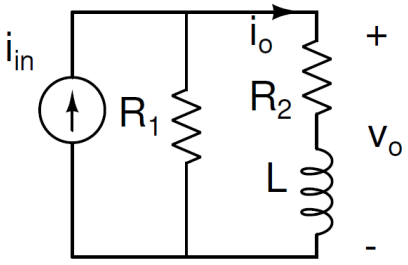
    1. All plots must be roughly to scale
    2. Key x and y axis values must be marked
    3. Time constant must be shown











11. (a) For the above circuits, find the impulse response by differentiating the step response

    (b) Verify your answer by finding the inverse Laplace transform of the transfer function.

    (c) In each circuit, find the poles and zeros and plot it in the compex frequency plane.

12. In the above questions find the steady state response by open circuiting the capacitor/short circuiting inductors. How are the values obtained related to the $v_o(t)$ and $i_o(t)$ you calculated earlier.

13. Using the initial and final value theorem, find $v_o(0^+)$ and $v_o(\infty)$. Use the transfer function you evaluated in question 11. and the Laplace transform of the input.