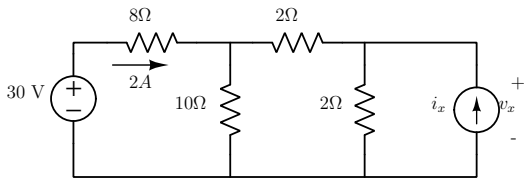
EC2015 Electric Circits and Networks – Tutorial 1

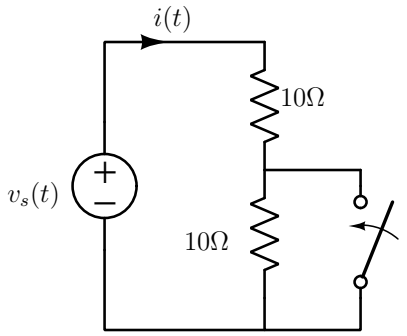
August 9th, 2024

1. Determine v_x in the circuit



2. Let $i(t) = \cos\omega_1 t + 2\cos\omega_2 t$. Find the frequencies present in $v(t)$ if the I-V characteristics is given as (a) $v(t) = 10i(t)$ and (b) $v(t) = 10i(t) + 0.1i(t)^2$.

3. As shown in the figure below, the switch is closed periodically at the rate of 1 kHz. If the input voltage $v_s(t) = \sin 1000\pi t$, what are the frequencies present in the output $i(t)$. Is the system linear? Time-invariant?



4. Plot the waveforms shown below

   (a) $u(t) - 2u(t-2)$

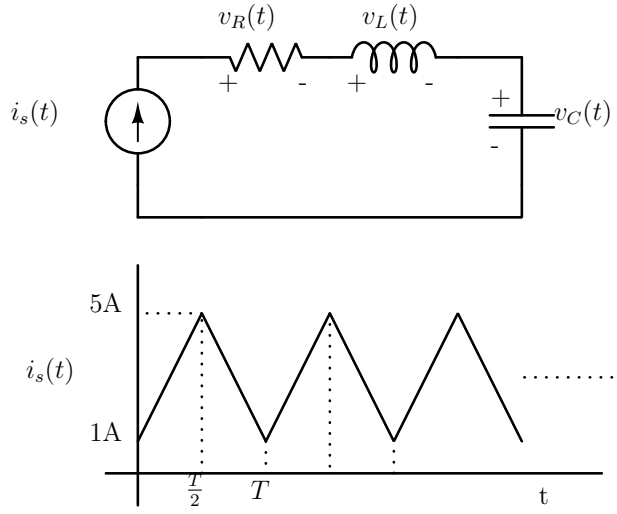
   (b) $\delta(t) - 2\delta(t-1) + \delta(t-2)$

   (c) $e^{-2t}u(t)$

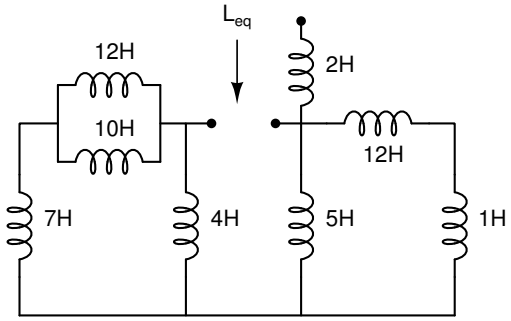
   (d) $\cos t\ u(t)$

5. If the above waveforms are branch currents, plot the branch voltages if the element is a linear time-invariant (a) inductor of 1H (ignore 3(b) in this case) (b) capacitor of 1F. Initial conditions are zero.

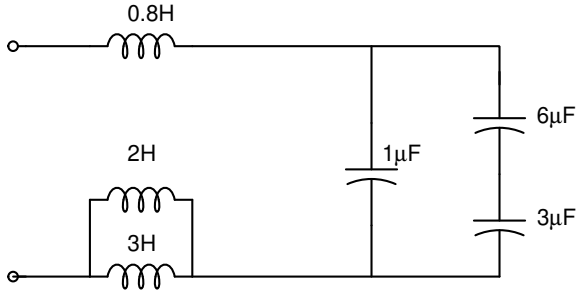
6. In the following circuit $R = 100\Omega$, $L = 1mH$ and $C = 1\mu F$. Determine the voltages $v_R(t)$, $v_L(t)$ and $v_c(t)$ if $i_s(t)$ is as shown below. Assume all initial conditions are zero.



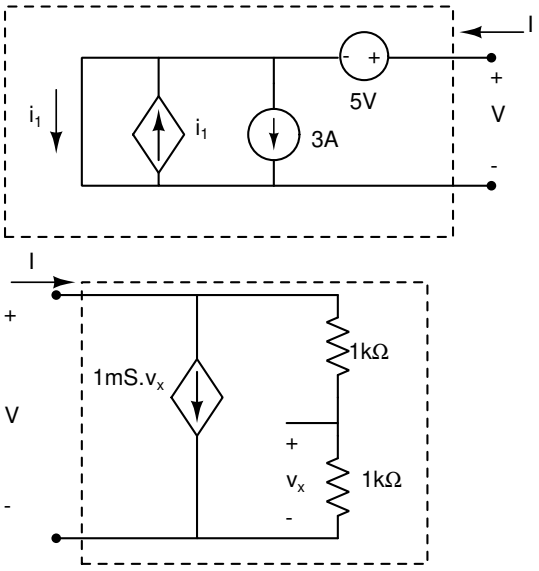
7. Determine L_{eq}



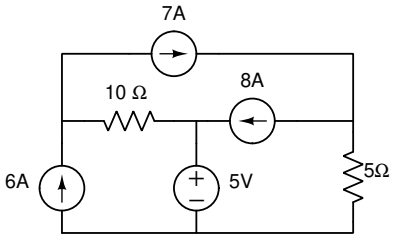
8. Simplify the following circuit using series-parallel combinations so that the final circuit contains only one inductor and one capacitor.



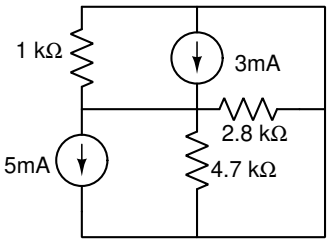
9. In the circuits shown below, sketch the I-V characteristics of the box.



10. In the following circuit, calculate the power dissipated or generated in each element. State clearly whether it is dissipated or generated.



11. For the given circuit determine the power absorbed by each resistor and the power supplied by each current source.

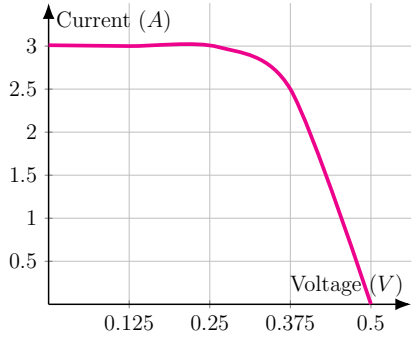


12. The current-voltage characteristic of a silicon solar cell exposed to direct sunlight is shown on the right. It is obtained by placing different-sized resistors across the two terminals of the device and measuring the resulting currents and voltages.

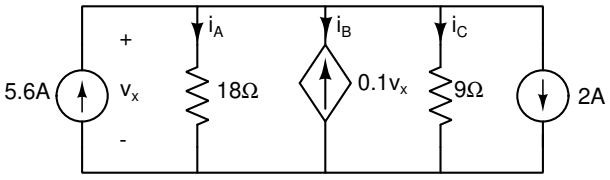
    (a) What is the value of the short-circuit current?

    (b) What is value of the voltage at open circuit?

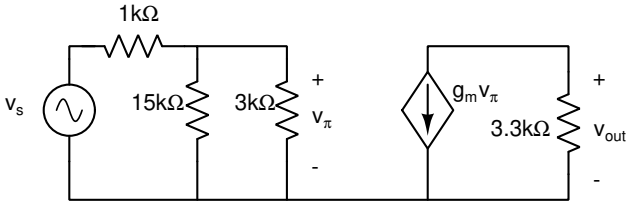
    (c) Estimate the maximum power that can be obtained from the device?



13. In the given circuit, find i_A, i_B and i_c.



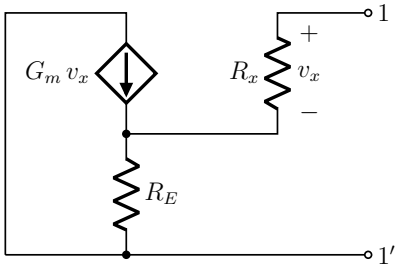
14. The circuit shown below is routinely employed to model mid-frequency operation of a bipolar junction transistor-based amplifier. Find the output v_{out} if the transconductance $g_m = 322$ mS and $v_s(t) = 6\cos 2300t\mu V$.



15. Consider the circuit shown below. What is the equivalent resistance as seen at the terminal pair $(1, 1')$?

$G_m = 1\,\text{mS}$
$R_x = 10\,\text{k}\Omega$
$R_E = 20\,\text{k}\Omega$

Hint: Connect a 1 A current source across terminals $(1, 1')$ and calculate $V_{11'}$.



16. (a) For the circuits given in (i) to (iv), calculate steady state values of v_L and i_L, if they exist. Assume $i_s = 1\,\text{mA}$ and $v_s = 2\,\text{V}$.

(b) For the circuits given in (v) and (vi), find out the currents i_C. Assume $i_s = 1\,\text{mA}$ and $v_s = 2\,\text{V}$.