Dr. Mohamed Bakr, EE2CI5, 2007

Note Title 10/18/2007

Lecture 18

From Section 7.1-7.2 of Text

Solve E7.1, E7.2, 7.1, 7.3, 7.5, 7.6, 7.11, 7.15, 7.17, 7.18

First order Circuits

* A first order circuit is a circuit having only one energy storage element.
* The equation governing voltage or current is a first order differential equation
* Solving this 1st order equation yields $v(t)$ and $i(t)$ in this circuit

Mathematical Notation

* first order eqn $\frac{dx(t)}{dt} + a\,x(t) = f(t)$
* $x(t)$ may be a voltage $v(t)$ or a current $i(t)$
* We first consider the constant excitation

Case $f(t) = A$

* The differential eqn $\frac{dx(t)}{dt} + a\,x(t) = A$

has the solution $x(t) = x_h(t) + x_{p.i}(t)$

Mathematical Theory (cont'd)

* The homogenous solution $x_h(t)$ is a solution to the homogenous system

$$\frac{dx(t)}{dt} + ax(t) = 0 \Rightarrow x(t) = x_0 e^{-at}$$

* The solution $x_h(t)$ represents circuit response due to its initial conditions when no excitation is present $f(t) = 0$

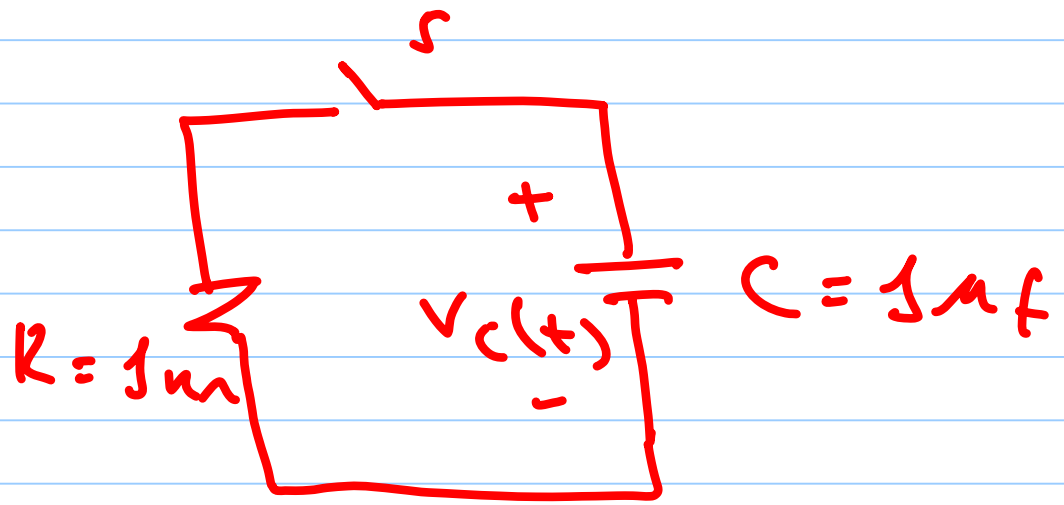
Mathematical Theory (cont'd)

* The particular integral solution $x_{PI}(t)$ is due to the excitation applied for $t > 0$

$$\frac{dx(t)}{dt} + a\,x(t) = A$$

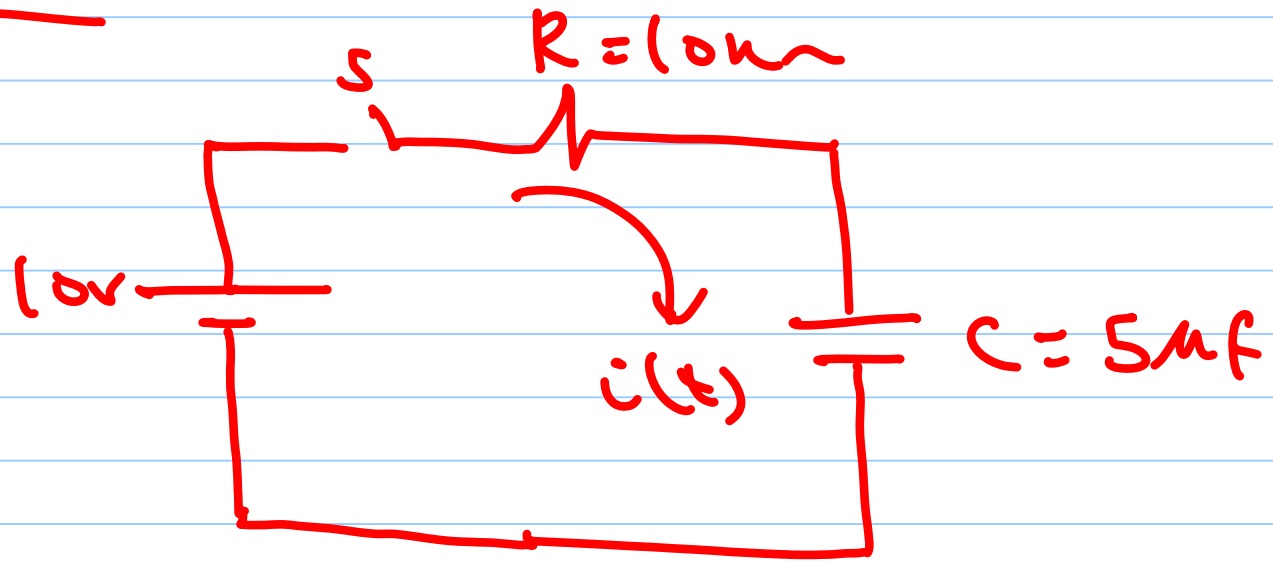
* This D.E. with zero initial condition has the solution $x(t) = \frac{A}{a}$

Example



The shown Capacitor is charged to $V_c(0) = 5V$, when the Capacitor S is closed at time t=0. find $V_c(t)$.

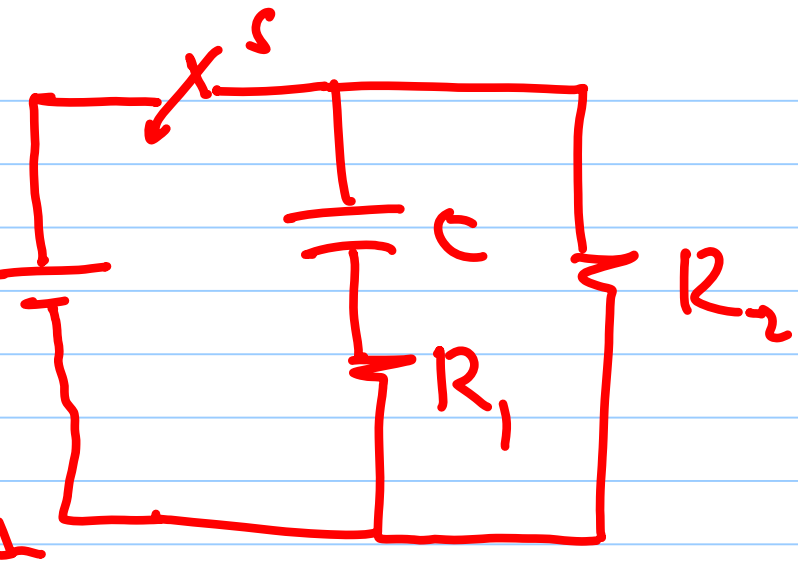
Example



At time $t = 0$, the switch S was closed. Find $i(t)$ assuming that $V_c(0) = 0$ V.

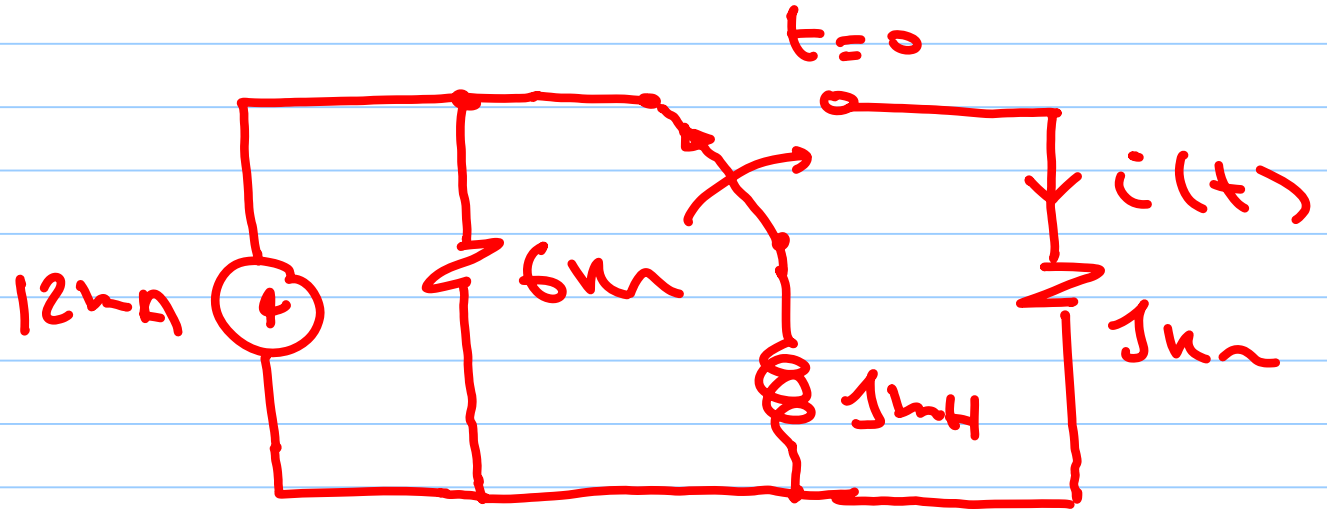
What is $V_c(\infty)$ and $i_c(\infty)$.

Example



The circuit shown was under steady state when the switch is opened at $t=0$. If $R_1 = 1.0\,\Omega$, $R_2 = 2.0\,\Omega$, and $C = 0.167\,F$, find $v_c(0^-)$, $v_c(0^+)$, $i_c(t)$ and $v_c(t)$

Example



Use the differential equation approach to find $i(t)$ for $t>0$. Plot the time response before and after switch is moved.