EE 2CI5: Mid-Term Test, 3 November 2010

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Examination Conditions

This test is conducted under standard examination conditions. In particular:

- You are not to communicate in any manner with any other student unless given explicit permission to do so by an invigilator.
- You are not to look at the questions nor start writing until told to do so by an invigilator.
- When the invigilator announces that the test is over, you are to stop writing *immediately*.

The penalties for violating these or any other standard examination conditions will be severe, including a zero on the test and the commencement of formal disciplinary proceedings.

Instructions

- When given permission to start writing, write your name and student number on the front page of the booklet.
- Do not use the front page of the booklet to answer any question.
- Please list the questions you have answered, in the order you attempted them, on the front page.
- Write your answers neatly and in a logical fashion. I may refuse to mark answers which are difficult to decipher.
- You may write your test in pencil, but booklets written in pencil or with pages torn out will not be remarked.
- There are 5 questions on the reverse side of this page. The marks for each question are indicated at the beginning of the question. Please bring any discrepancy to the attention of an invigilator.

Useful Information

- The solutions to the quadratic equation $ax^2 + bx + c = 0$ are $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$.
- Current and voltage relationships for a capacitor of C Farads:

$$i_C(t) = C\frac{dv_C(t)}{dt}, \qquad v_C(t) = \frac{1}{C}\int_{-\infty}^{t} i_C(\lambda)\, d\lambda,$$

- Current and voltage relationships for an inductor of L Henries:

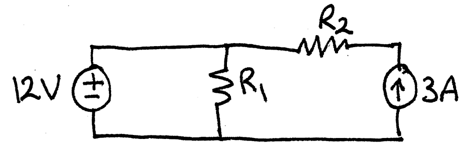
$$v_L(t) = L\frac{di_L(t)}{dt}, \qquad i_L(t) = \frac{1}{L}\int_{-\infty}^{t} v_L(\lambda)\, d\lambda,$$

- The solution to a first-order linear differential equation with constant coefficients takes the form $x(t) = x_n(t) + x_f(t)$, where the natural response takes the form $x_n(t) = Ke^{-t/\tau}$. For certain forcing functions, the forced response takes the form

$$x_f(t) = \begin{cases} A & \text{if the forcing function is a constant } D \\ A\sin(\omega t) + B\cos(\omega t) & \text{if the forcing function is } D\cos(\omega t + \theta) \\ Ae^{-at} & \text{if the forcing function is } De^{-at},\ a \neq 1/\tau \end{cases}$$

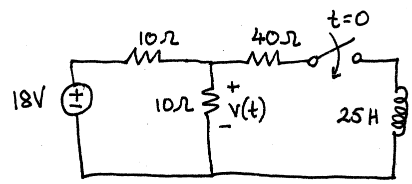
Questions

1. (10 marks) Consider the following circuit:



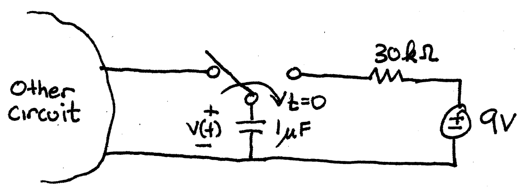
The voltage source supplies 24W of power and the current source supplies 45W of power. Find the values of the resistors, R_1 and R_2.

2. (10 marks) Consider the following circuit:



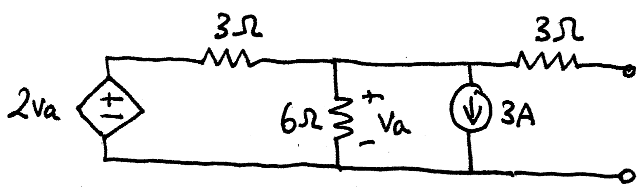
The switch has been in the open position for a long period of time, and then closes at time $t = 0$. Find the voltage $v(t)$ for $t > 0$.

3. (10 marks) Consider the following circuit, in which the portion labelled "Other Circuit" is unknown.



Let t be measured in seconds.
For $-20 \times 10^{-3} < t < 0$, the voltage $v(t) = 13e^{-(t+20\times10^{-3})/(10\times10^{-3})}$.
Find $v(t)$ for $t \geq 0$.

4. (10 marks) Find the Thevenin equivalent of the following circuit.



5. (10 marks)

(a) Sketch a (zero-mean) 2kHz square wave of 3V peak-to-peak.

(b) Denote that square wave by $v_x(t)$ and find $i(t)$ in the following circuit.