ShanghaiTech University

Spring 2018, EE111----Electric Circuit

Midterm 2

May.7th

Student Name: ___________________

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- This test contains 14 numbered pages, including the cover page, printed on both sides of the sheet.

- You have 120 minutes to complete this exam. The exam is closed book; no computers, phones, or calculators with programming, imagining, storage and other electronic devices are allowed.

- Please turn off all cell phones, smartwatches, and other mobile devices. Remove all hats and headphones. Put everything (except the calculator with basic function) in your backpack. Place your backpacks, laptops and jackets out of reach.

- There may be partial credit for incomplete answers; write as much of the solution as you can. We will deduct points if your solution is far more complicated than necessary.

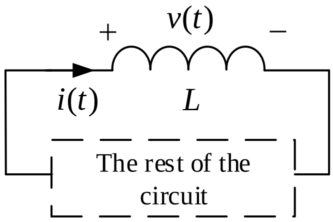
- Please prepare your submission in English only. **No Chinese submission will be accepted.**

Question	Points	Score	Viewer
1	15		
2	20		
3	15		
4	15		
5	15		
6	20		
Total	100		

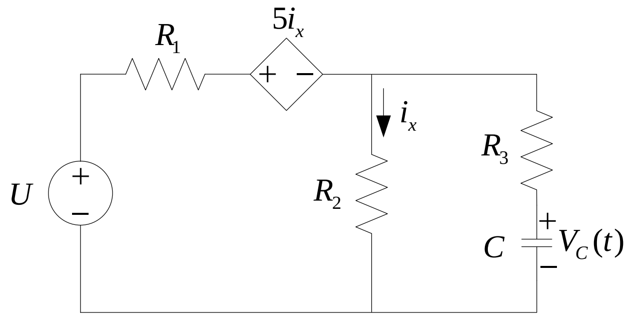
1. Activation of a switch at the time $t=0$ in a certain circuit caused the voltage across a $L=20\,\mathrm{mH}$ inductor to exhibit the voltage response:

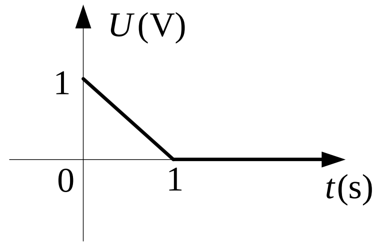
$$v(t)=4e^{-0.2t}\mathrm{mV} \quad t>0$$

Determine $i(t)$ for $t>0$, given the energy stored in the inductor at $t=\infty$ is $0.64\mathrm{mJ}$.



2. In the circuit below, $R_1 = 10\ \Omega,\ R_2 = 5\ \Omega,\ R_3 = 10\ \Omega,\ C = 10\ \text{mF}$. When $t < 0$, the input voltage (U) is $1\,\text{V}$. When $t = 0$, the input voltage begins to change as shown in the plot below. When $t > 1\text{s}$, $U = 0$. Assume that the circuit reaches steady state before $t = 0$. Determine the expression for $V_C(t)$ when $t \geq 0$.





3. When the input to the circuit shown in the figure is the voltage source,

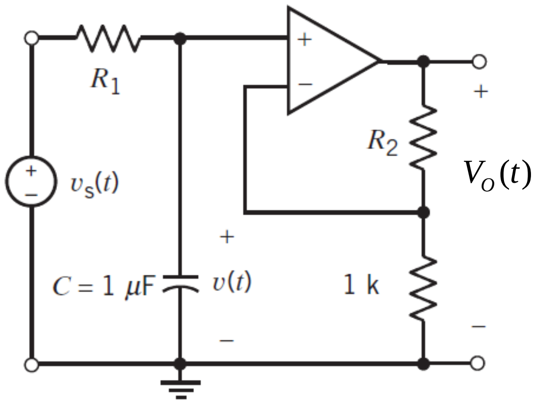
$$V_s(t) = 3 - u(t) \quad \text{V}$$

The output is the voltage

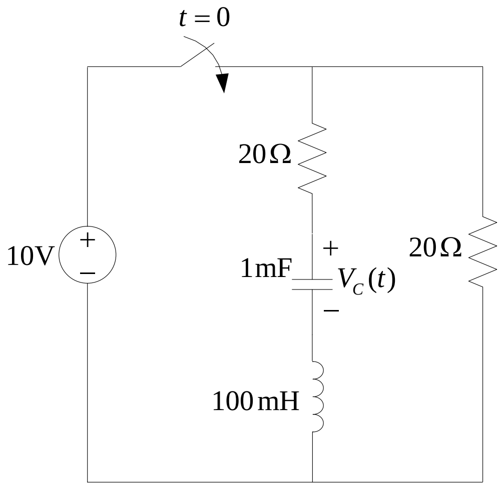
$$V_O(t) = 10 + 5e^{-50t} \quad \text{V}, \ t \ge 0 .$$

Determine the values of R_1 and R_2.

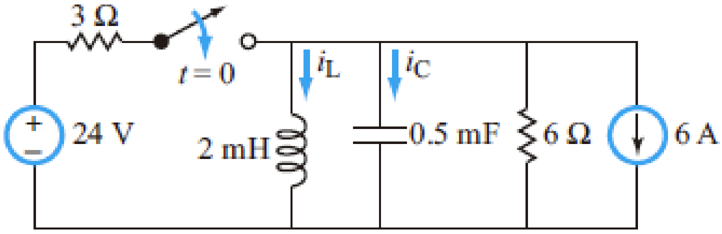
(Assume that the circuit reached steady state before $t = 0$.)



4. In the circuit below, the initial energy stored in the whole circuit is zero. At the time $t = 0$, the switch is closed and a DC voltage source of $10\,\mathrm{V}$ is applied to the circuit. Determine the expression of $V_C(t)$ for $t > 0$.



5. Determine $i_L(t)$ in the circuit for $t \geq 0$. Assume that the circuit reaches steady state before $t = 0$.



6. In this basic RLC circuit, suppose the capacitor is $100\,\text{nF}$, $V = 100\text{V}$. Before $t = 0$, there is no energy stored in either the capacitor or the inductor. At $t = 0$, the switch is closed. When $t > 0$, the first time V_C exceeds (超过) $100\,\text{V}$, it reaches a peak of $176.82\,\text{V}$ at the time $t = \frac{\pi}{4}$ ms. The second time voltage V_C exceeds 100V, it reaches a peak of $145.34\,\text{V}$ at the time $t = \frac{3\pi}{4}$ms.

(1) Determine the circuit is overdamped, critically damped or underdamped.

(2) Choose three of the four parameters: $V,\ \alpha,\ \omega_0$ and ω_d, to express $V_C(t)$ as a function of t for $t > 0$. (Hint: The parameters $\alpha,\ \omega_0$ and ω_d are defined the same as what have been covered in class. Details are as follows.

The second-order differential equation that $V_C(t)$ should obey is: $\frac{d^2V_C(t)}{dt^2} + 2\alpha\frac{dV_C(t)}{dt} + \omega_0^2 V_C(t) = f(t)$, where $f(t)$ is a function of t and is determined by the circuit. If $\alpha < \omega_0$, $\omega_d = \sqrt{\omega_0^2 - \alpha^2}$.)

(3) Choose three of the four parameters: $V,\ \alpha,\ \omega_0$ and ω_d to express $\frac{dV_C(t)}{dt}$ as a function of t for $t > 0$.

(4) Find the numerical values of R and L.