2nd Midterm for Electric Circuits (Chapter 5-8)

May 15, 2023

Time: 110 minutes (10:10-12:00)

Instructions:

1. Please sign and return this exam paper with the answer sheet.
   於試題卷上簽名，與答案卷一同繳回。
2. This is not an open-book exam. Do not use any notes. Do not use the pencil. Calculator is allowed.
   不可看書、不可使用小抄、不可使用鉛筆作答，但可使用計算機。
3. Please clearly address the question number on the answer sheet. Answer the multiple choice questions on the answer sheet. No need to include the calculation process for "Multiple choice question".
   請在答案卷上清楚標註題號；**選擇題答案請寫在答案卷上**(選擇題不需寫計算過程)。
4. Raise your hand to ask questions, do not discuss with others.
   任何問題請舉手問助教，切勿逕行與同學討論。
5. Students who do not submit their tests at the end of the examination period will receive a score of zero. Students who cheat in their tests will also receive a zero.
   未繳回考卷或有作弊情事者以零分計算。

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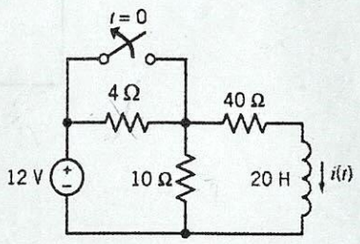
1. (c) [5 points] The circuit below is at steady state before the switch close. Find the initial inductor current after the switch closes.

   (a) 0.1 A (b) 0.2 A (c) 0.3 A (d) 1.2 A



2. (b) [5 points] Following the previous question, how much is the final inductor current?

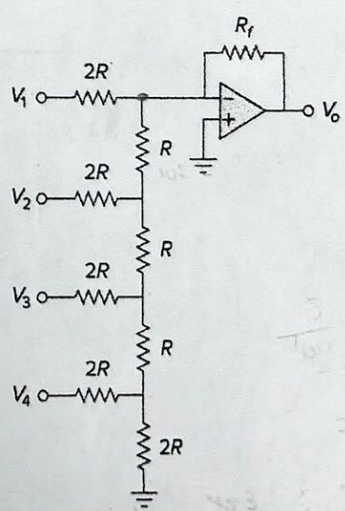
   (a) 0.1 A (b) 0.2 A (c) 0.3 A (d) 1.2 A

3. (b) [5 points] An RL circuit has R = 2 Ω and L = 4 H with an applied constant source. The time needed for the inductor current to reach 40 percent of its steady-state value is:

   (a) 0.5 s (b) 1 s (c) 2 s (d) 4 s

4. (d) [5 points] A four-bit R-2R ladder DAC is presented in the right figure. The output voltage is given by $-V_o = R_f\left(\frac{V_1}{2R}+\frac{V_2}{4R}+\frac{V_3}{8R}+\frac{V_4}{16R}\right)$, if R_f = 12 $k\Omega$ and R = 10 $k\Omega$. How much is |Vo| for the input [V1V2V3V4] = [0101].

   (a) 1.125 V (b) 825 mV (c) 525 mV (d) 375 mV



5. (a) [5 points] Following the previous question, how much is resolution of the four-bit DAC per discrete

binary step if it covers a voltage range of 0 to 15 V?

(a) 1 V (b) 0.938 V (c) 0.25 V (d) 0.125 V

6. [10 points] For the circuit in **Fig. 1**, obtain the Thevenin equivalent as seen from terminals (a) a-b and (b) b-c. (a) $V_{TH} = 4V$, $R_{TH} = \frac{27}{7}\Omega$, (b) $V_{TH} = 15V$, $R_{TH} = \frac{45}{14}\Omega$

7. [10 points] Determine the maximum power that can be delivered to the variable resistor R in the circuit of **Fig. 2**. 9W

8. [10 points] A noninverting current amplifier is portrayed in **Fig. 3**. Calculate the gain i_o/i_s. Take $R_1 = 9\ k\Omega$ and $R_2 = 1\ k\Omega$. 10.

9. [10+5 points] The initial capacitor voltage of the circuit in **Fig. 4** is $v_c(0) = 3\ V$. Determine (a) the voltage $v(t)$ and (b) the maximum energy stored when $i(t) = \begin{cases} 3e^{5t}, & 0 < t < 1 \\ 0, & t \geq 1 \end{cases}$

(a) $v(t) = \begin{cases} 3 & t \leq 0 \\ 18e^{5t} & 0 < t < 1 \\ 3e^{5} & t \geq 1 \end{cases}$ (b) $\frac{9}{10}e^{10}$ [J]

10. [10 points] An op amp differentiator has R = 250 $k\Omega$ and C = 10 μF. The input voltage is a ramp r(t) = 12 t mV. Find the output voltage. −0.03V

11. [10 points] A 10 – V dc voltage is applied to an integrator with R = 250 $k\Omega$, C = 100 μF at t = 0. How long will it take for the op amp to saturate if the saturation voltages are +12 V and – 12 V? Assume that the initial capacitor voltage was zero. 30s

12. [10 points] For two capacitors in parallel as in **Fig.5**, express i_1 and i_2 in terms of i_s, assuming that the initial conditions are zero.

$\begin{cases} i_1 = \left(\frac{C_1}{C_1+C_2}\right) i_s \\ i_2 = \left(\frac{C_2}{C_1+C_2}\right) i_s \end{cases}$

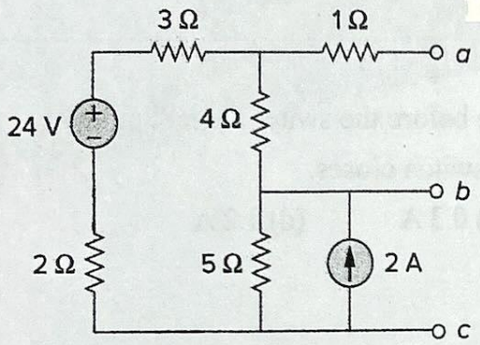


Fig.1

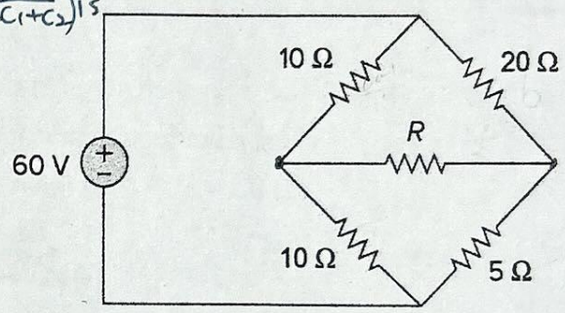


Fig.2

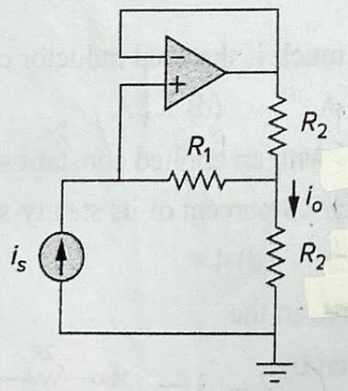


Fig.3

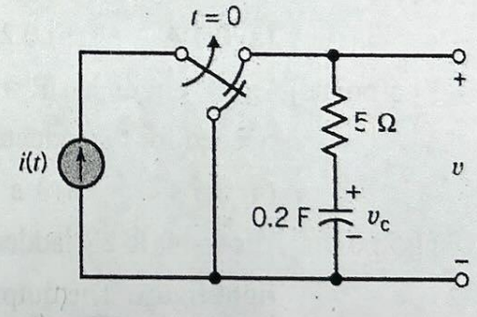


Fig.4

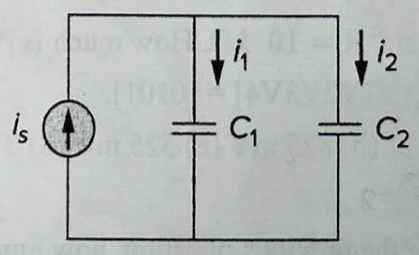


Fig. 5