National Chiao Tung University
Computer Science Department

INTRODUCTION TO ELECTRIC AND ELECTRONIC CIRCUITS

Assignment [1] : Basic Electric Circuits

Instructor:	Prof. John K. Zao
Issuing date:	Tuesday, October 23, 2012
Submission due date:	Tuesday, November 6, 2012

Homework Reading

- Zao & Peng, "EE Circuit Notes", 2008 — pp. 1 – 11
- Strum & Ward, "Electric Circuits and Networks", 2nd Ed., 1985 — Ch. 1 & 2; pp. 1 – 48

Part 1. Conceptual Questions **40%**

1.1 Please use concise statements or formulae to define what a *linear system* is and how its behaviors relate to the *law of superposition*. 4%

1.2 Please define the concepts of *open circuit*, *short circuit*, *parallel connections* and *serial connections* in an electric circuit. 4%

1.3 Please derive the relation between *electric power* $p(t)$, *voltage* $v(t)$ and *current* $i(t)$ across an electric element from the definition of electric power. 6%

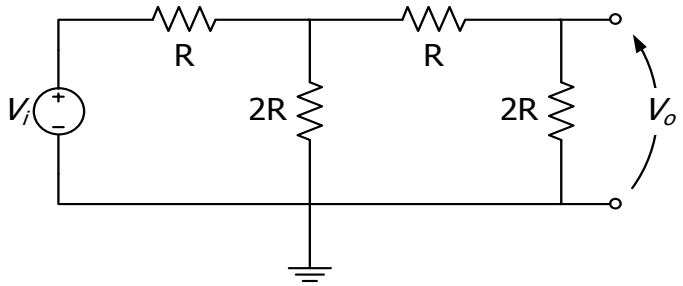
1.4 Please definite the *root-mean-square voltage value* V_{rms} across a resistor R and relates the quantity to the *electric power* dissipated by the resistor. 4%

1.5 Please give precise statement of *Kirchhoff's Voltage and Current Laws (KVL/KCL)* and explain their underlying principles. 8%

1.6 Please define the *Thevenin and Norton equivalent circuits* of a linear circuit. 4%
Then, derive the equivalent *voltage* v_{Th}, *current* i_N and resistance R_{Th}, *conductance* G_N of these circuits. 8%
Please explain why the circuit must be *linear* in order for the models to be valid. 2%

Part 2. Analytical Questions **60%**

2.1 Please use *KVL loop analysis* to write the equations for the following circuit. 8%
Then, compute the output voltage of the circuit in terms of the input voltage v_I. 6%

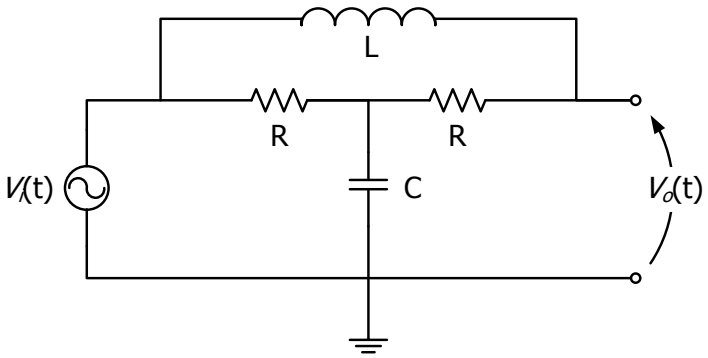


2.2 Please determine the *Thevenin equivalent* of the entire circuit above. 5%

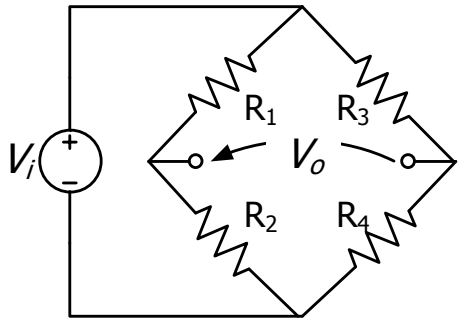
2.3 Please use *KVL loop analysis* to deduce the circuit equations that relates the input/output relation of the circuit at the top of next page. 7%

Then, try to use *KCL node analysis* to write the equations again for the same circuit. 8%

Note: There is no need to solve these equations.



2.4 Please use KVL/KCL to analyze the famous *Wheatstone bridge* and determine the condition for $\boldsymbol{V_o}$ to be *zero*. Such a condition is known as the *balanced condition*. 6%



Assume now the bridge is no longer balanced, what are the ratios among R_1, R_2, R_3, R_4 that can make $V_o = V_i/2$? 4%

Hint: Assume $R_1 = R_3 = R$ and find the ratio between R_2 and R_4.

2.5 Please solve for the *output voltage* $\boldsymbol{V_o}$ of the following *two-source circuit* based on the law of superposition. 10%