Name..ID............................Section........1........Seat No............

Sirindhorn International Institute of Technology
Thammasat University

Sample Midterm Examination

Course Title: ECS203 (Basic Electrical Engineering)

Instructor: Asst. Prof. Dr.Prapun Suksompong

Date/Time (for the real exam): March 8, 2016 / 13:30 - 16:30

Instructions:

- This examination has....10....pages (including this cover page).
- Conditions of Examination:
  ....Closed book
  (No dictionary, ☐ No calculator ☑ Calculator (e.g. FX-991MS) allowed)
  ....Open book
  ......✓.....**Semi-Closed book** (........1........sheet(s) ☑ 1 page ☐ both sides of A4 paper note)
  This sheet must be hand-written. It should be **<u>submitted with the exam</u>**.
- **<u>Read</u> these instructions and the questions carefully**.
- Students are not allowed to be out of the examination room during examination. Going to the restroom may result in score deduction.
- Turn off all communication devices and place them with other personal belongings in the area designated by the proctors or outside the test room.
- Write your name, student ID, section, and seat number clearly in the spaces provided on the top of this sheet. Then, write your **first name and the <u>last three digits</u> of your ID** in the spaces provided on the top of each page of your examination paper, starting from page 2.
- <u>The back of each page</u> will <u>not</u> be graded; it can be used for calculations of problems that do not require explanation.
- The examination paper is not allowed to be taken out of the examination room. Also, do not remove the staple. Violation may result in score deduction.
- Unless instructed otherwise**,** ***<u>write down all the steps</u>*** that you have done to obtain your answers.
  - When applying formula(s), state clearly which formula(s) you are applying before plugging-in numerical values.
  - You may not get any credit even when your final answer is correct without showing how you get your answer.
  - Formula(s) not discussed in class can be used. However, derivation must also be provided.
- When not explicitly stated/defined, all notations and definitions follow ones given in lecture.
- For the calculation of absorbed power, if the power is actually supplied by the element, then your corresponding answer will be negative.
- Units are important.
- Some points are reserved for *accuracy* of the answers and also for reducing answers into their *simplest* forms.
- Points marked with * indicate challenging problems.
- Do not cheat. Do not panic. Allocate your time wisely.

Name____ ID_________________________

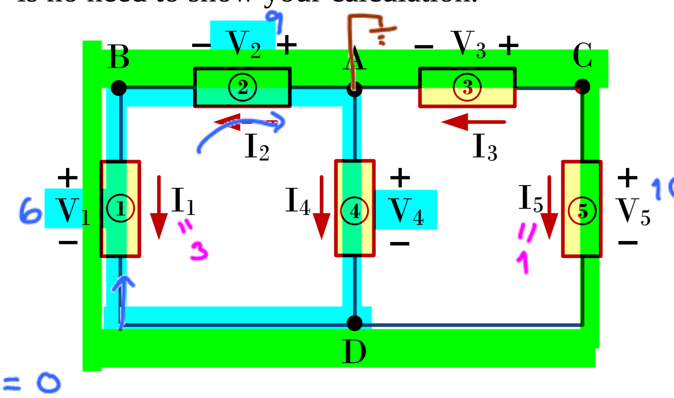
KVL around left mesh

$6+9-V_4=0$

KVL around outer loop

$6+9+V_3-10=0$

1. (22 pt) Consider the circuit shown in Figure 1. Some branch voltage and current values are provided below. For this question, only the answers are required. There is no need to show your calculation.



$V_1 = 6$ V　　$I_1 = 3$ A

$V_2 = 9$ V　　$I_2 =$ ____ A

$V_3 =$ <u>−5</u> V　　$I_3 =$ ____ A

$V_4 =$ <u>15</u> V　　$I_4 =$ <u>−4</u> A

$V_5 = 10$ V　　$I_5 = 1$ A

KCL @ D

$-I_1 - I_4 - I_5 = 0$

$3 \quad\quad 1$

$B \xrightarrow[9]{} A \xrightarrow[-5]{} C$

$B \xrightarrow[4]{} C \quad V_B + 4 = V_C$

Figure 1

a. (5 pt) Find the rest of the voltage and current values. Put your answers in the appropriate spaces above.

b. (3 pt) Find V_{BA} and V_{BC}.

$V_B - V_C =$

$V_{BA} =$ <u>$-V_2 = -9$</u> V and $V_{BC} =$ <u>−4</u> V.

c. (3 pt) Find the power absorbed by element 1 and the power absorbed by element 4. (Note that if the power is actually supplied by the element, then your corresponding answer will be negative.)

enter "+"　　enter "+"

$P_1 =$ <u>$V_1 I_1 = 18W$</u> and $P_4 =$ <u>$I_4 V_4 = (-4)(15) = -60W$</u>.

d. (1.5 pt) Can element 1 be a resistor?
If yes, find its resistance. If no, provide reason.

enter "+"

Yes, $V_1 = I_1 R_1 \Rightarrow R_1 = \frac{V_1}{I_1} = \frac{6}{3} = 2\ \Omega$

e. (1.5 pt) Can element 4 be a resistor?
If yes, find its resistance. If no, provide reason.

No, $P_4 < 0$; so it supplies power. Resistor can't supply power.

f. (4 pt) Suppose **node A** is selected as the reference (ground) node. Find the values of all node voltages in the circuit.

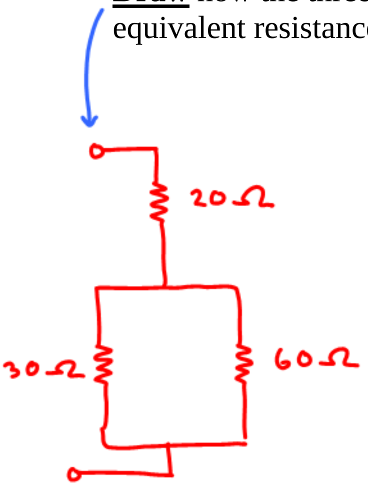
$V_A =$ <u>0 V</u>, $V_B =$ <u>−9V</u>, $V_C =$ <u>−5V</u>, $V_D =$ <u>−15V</u>.

g. (4 pt) Suppose **node B** is selected as the reference (ground) node. Find the values of all node voltages in the circuit.

$V_A =$ <u>9V</u>, $V_B =$ <u>0 V</u>, $V_C =$ <u>4V</u>, $V_D =$ <u>−6V</u>.

Name______________________________________ ID________________________

2. (5 pt) Suppose you want to use a 40 Ω resistor but you only have one 20 Ω resistor, one 30 Ω resistor, and one 60 Ω resistor. How would you connect the three resistors to get 40 Ω?
<u>Draw</u> how the three resistors are connected *and* **<u>show</u>** your calculation of the equivalent resistance.



3. (29 pt) In this question, you **must** use the specified techniques to solve the problem. There will be **<u>no credit</u>** given if you do not follow the instructions. As always, your score depends strongly on your explanation of your answer. If the explanation is incomplete, zero score may be given even when the final answer is correct.

Let

$$V_S = 6\text{ V and } R_1 = R_2 = R_3 = 2\ \Omega.$$

<u>Use the above values for all parts of this question.</u>

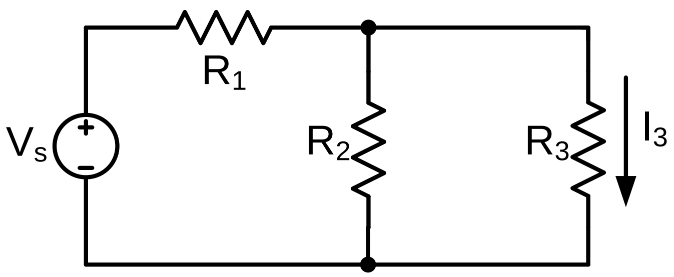


Figure 2

a. (6 pt) Consider the circuit in Figure 2. Find I_3 by first applying **<u>source transformation</u>** once and then use any method of your choice to find I_3.

1A

Name____ ID_________________________

b. (6 pt) Use **nodal analysis** to obtain V_a in Figure 3. Then, use V_a and the resistance value(s) to **find** I_3.

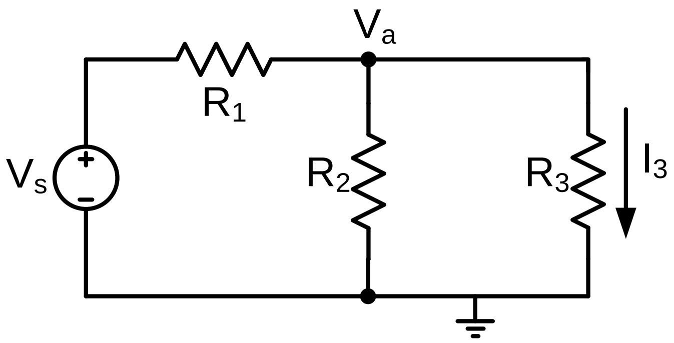


Figure 3

1 A.

c. (6 pt) Use **mesh analysis** to **find all** mesh currents in Figure 4. Then, use the mesh current(s) to **find** I_3.

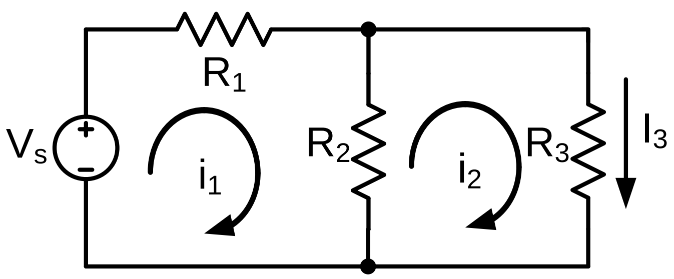


Figure 4

$i_1 = 2A$
$i_2 = 1A$

$I_3 = 1A$

Name____ ID_________________________

d. (6 pt) In this part, we will find the **Norton equivalent** of the circuit (with respect to terminals a and b) in Figure 5.

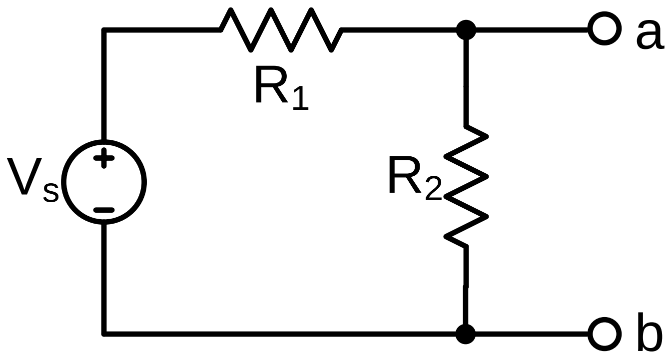
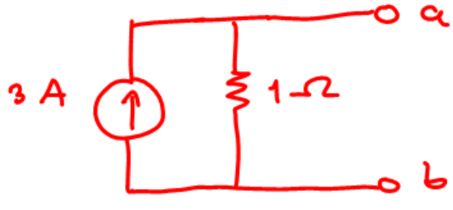


Figure 5

i. Draw the circuit that is used to find I_N (from its definition) and then find I_N.
ii. Draw the circuit that is used to find R_N from Figure 5 and then find R_N.
iii. Draw the **Norton equivalent** of the circuit in Figure 5.



e. (5 pt) Use your answers from part (d) to determine I_3 in Figure 2.

1A

Name_______________________________________ ID________________________

4. (3~~3~~ 1 pt) In this question, you **must** use the specified techniques to solve the problem. There will be **<u>no credit</u>** given if you do not follow the instructions. As always, your score depends strongly on your explanation of your answer. If the explanation is incomplete, **<u>zero</u>** score may be given even when the final answer is correct.

<u>Use the following values for all parts of this question:</u>

$V_S = 24$ V, $I_S = 2$ A, $R_1 = R_2 = 3\ \Omega$, and $R_3 = R_4 = 6\ \Omega$.

Consider the circuit in Figure 6.

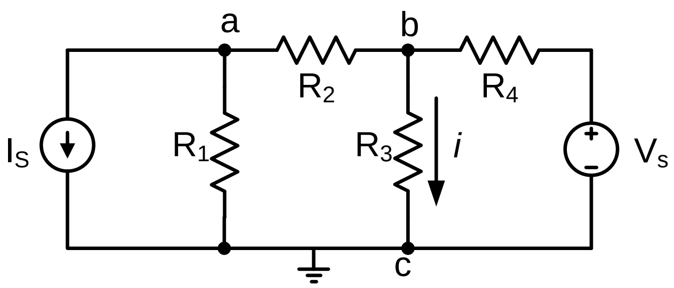


Figure 6

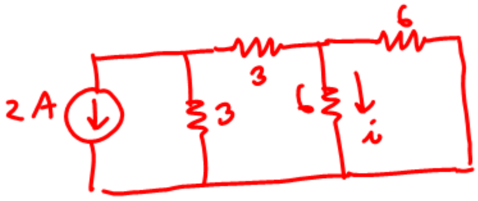
a. (5 pt) Use **<u>source transformation(s)</u>**, resistor combination(s), source combination(s) and one application of the ~~voltage~~ current divider formula to find i.

1 A

Name____ ID________________________

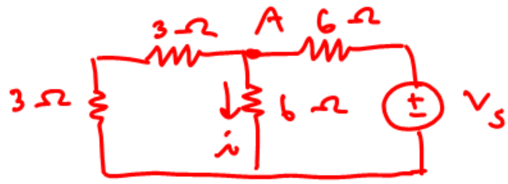
b. (8 pt) We will now use **superposition theorem** to find *i*.

(b.i) (3 pt) **Draw** the sub-circuit when **only I_S** is activated. Then, **find** *i* for this sub-circuit using any technique(s) of your choice.



$-\frac{1}{3}$ A

(b.ii) (3 pt) **Draw** the sub-circuit when **only V_S** is activated. Then, **find** *i* for this sub-circuit using any technique(s) of your choice.



$\frac{4}{3}$ A.

(b.iii) (2 pt) Use *i* from parts (b.i) and (b.ii) to find *i* in Figure 6.

superposition : $i = \frac{4}{3} + \left(-\frac{1}{3}\right) = \frac{3}{3} = 1$ A

c. (5 pt) Use **nodal analysis** to **find V_a and V_b** in Figure 6 and then find *i* from V_b.

$V_a = 0$ V

$V_b = 6$ V

$i = 1$ A

Name____ ID_________________________

d. (5 pt) Determine R_{th} and V_{th} at terminals b-c of the circuit in Figure 7.

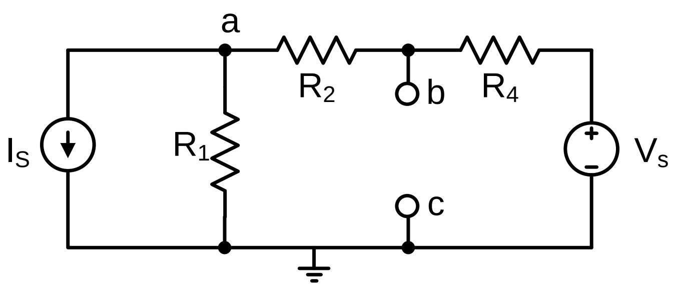


Figure 7

$R_{TH} = 3\,\Omega$

$V_{TH} = 9\ V$

e. (5 pt) Use your answers **<u>from part (d)</u>** to help determine *i* in Figure 6.

1 A

f. (3 pt) Determine R_N and I_N at terminals b-c of the circuit in Figure 7.

$R_N = 3\,\Omega$, $I_N = 3\ A$

Name____ ID_________________________

5. (6 pt) Consider the circuit in Figure 8. Suppose

$$V_S = 24\text{ V},\ I_S = 2\text{ A},\ R_1 = R_2 = 3\ \Omega,\text{ and } R_4 = 6\ \Omega.$$

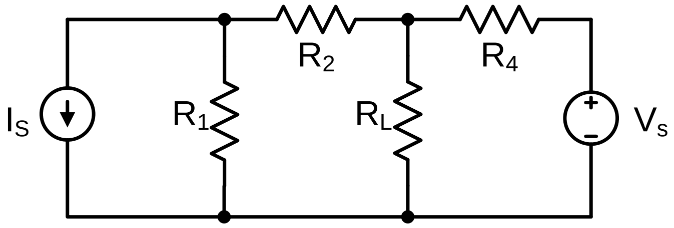


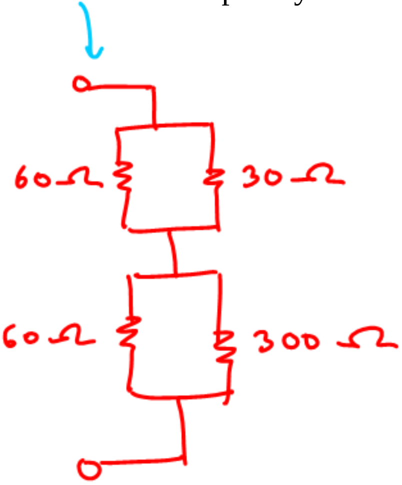
Figure 8

Find the value of the load resistance R_L for maximum power transfer (to the load). Also, find the corresponding amount of maximum power.

$R_L^* = 3\ \Omega$

max $P_L = \frac{27}{4}$ W.

6. (2 pt) Suppose you want to use a 70 Ω resistor but you only have two 60 Ω resistors, one 30 Ω resistor, and one 300 Ω resistor. How would you connect the four resistors to get 70 Ω?
Draw *and* explain your answer.



Name____ ID_________________________

7. (4* pt) In this question, you **must** use the specified techniques to solve the problem. There will be **<u>no credit</u>** given if you do not follow the instructions. As always, your score depends strongly on your explanation of your answer. If the explanation is incomplete, zero score may be given even when the final answer is correct.

   Consider the circuit in Figure 9.

   Suppose $R_1 = R_2 = R_3 = R_4 = 5\ \Omega$, and $R_5 = 11\ \Omega$.

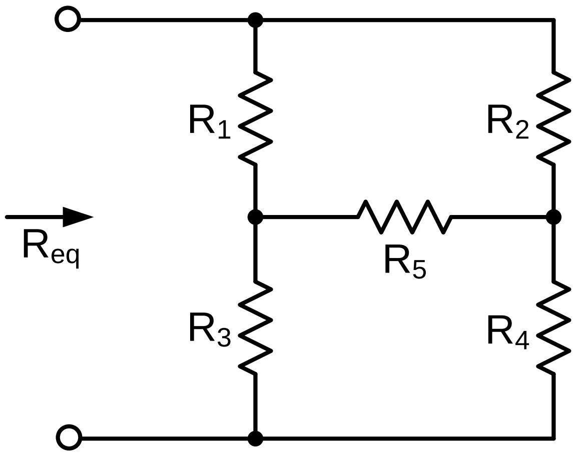


Figure 9

   a. (2 pt) Find R_{eq} using **<u>nodal analysis</u>**.

$5\ \Omega$

   b. (2 pt) Find R_{eq} using **<u>mesh analysis</u>**.

$5\ \Omega$

8. (1 pt) Do not forget to submit your study sheet with your exam.