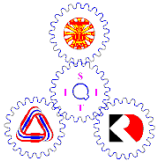


Name.....ID.....Section.....1.....Seat No.....



# 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 **submitted with the exam.**
- **Read 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 last three digits of your ID** in the spaces provided on the top of each page of your examination paper, starting from page 2.
- The back of each page will not 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, write down all the steps 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.

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.

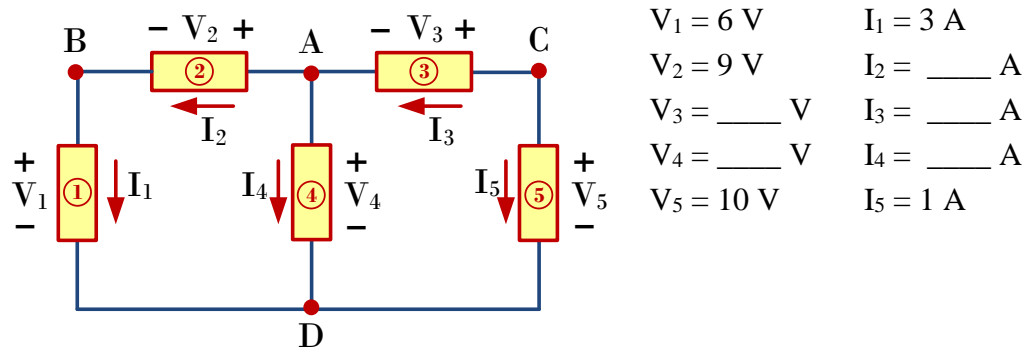


Figure 1

- 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  $V_{BC}$ .

$$V_{BA} = \text{ \_\_\_\_\_\_ } \text{ V} \quad \text{and} \quad V_{BC} = \text{ \_\_\_\_\_\_ } \text{ V}.$$

- 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.)

$$P_1 = \text{ \_\_\_\_\_\_ } \quad \text{and} \quad P_4 = \text{ \_\_\_\_\_\_ }.$$

- d. (1.5 pt) Can element 1 be a resistor?  
If yes, find its resistance. If no, provide reason.
- e. (1.5 pt) Can element 4 be a resistor?  
If yes, find its resistance. If no, provide reason.
- f. (4 pt) Suppose node A is selected as the reference (ground) node. Find the values of all node voltages in the circuit.

$$V_A = \text{ \_\_\_\_\_\_ }, V_B = \text{ \_\_\_\_\_\_ }, V_C = \text{ \_\_\_\_\_\_ }, V_D = \text{ \_\_\_\_\_\_ }.$$

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

$$V_A = \text{ \_\_\_\_\_\_ }, V_B = \text{ \_\_\_\_\_\_ }, V_C = \text{ \_\_\_\_\_\_ }, V_D = \text{ \_\_\_\_\_\_ }.$$

2. (5 pt) Suppose you want to use a  $40\ \Omega$  resistor but you only have one  $20\ \Omega$  resistor, one  $30\ \Omega$  resistor, and one  $60\ \Omega$  resistor. How would you connect the three resistors to get  $40\ \Omega$ ?

**Draw** how the three resistors are connected *and* **show** 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 **no credit** 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

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

**Use the above values for all parts of this question.**

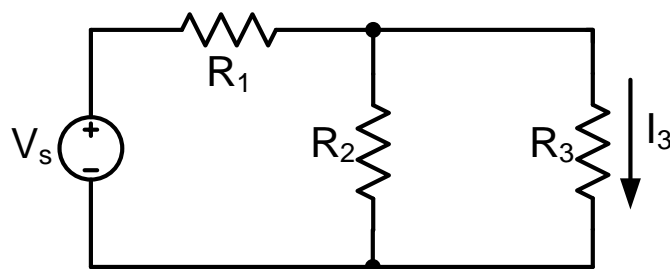


Figure 2

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

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

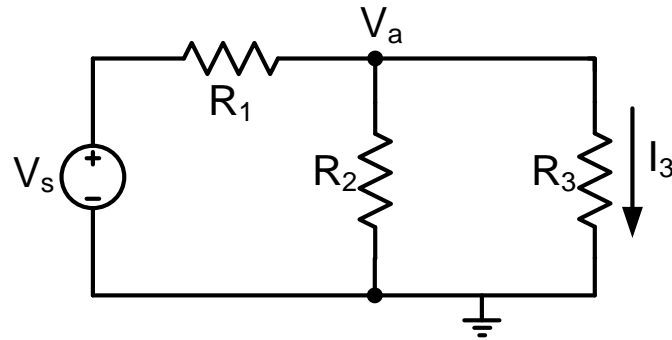


Figure 3

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

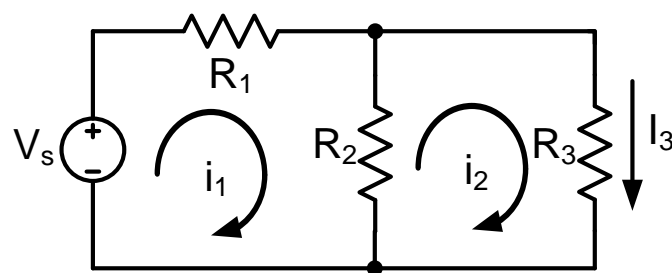


Figure 4

- 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.

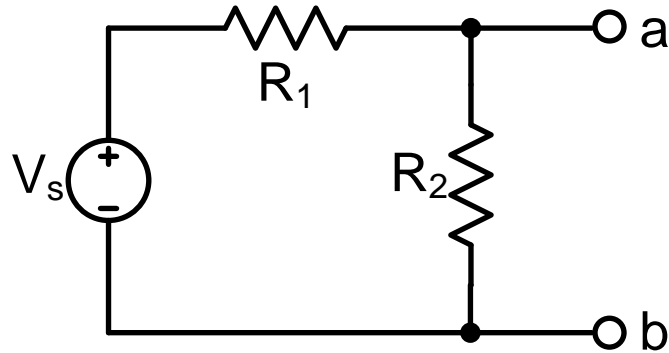


Figure 5

- 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.

4. (3<sup>1</sup> pt) In this question, you **must** use the specified techniques to solve the problem. There will be **no credit** 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.

**Use the following values for all parts of this question:**

$$V_s = 24 \text{ V}, I_s = 2 \text{ A}, R_1 = R_2 = 3 \Omega, \text{ and } R_3 = R_4 = 6 \Omega.$$

Consider the circuit in Figure 6.

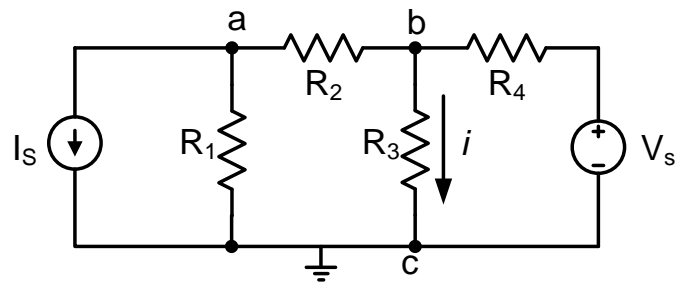


Figure 6

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

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

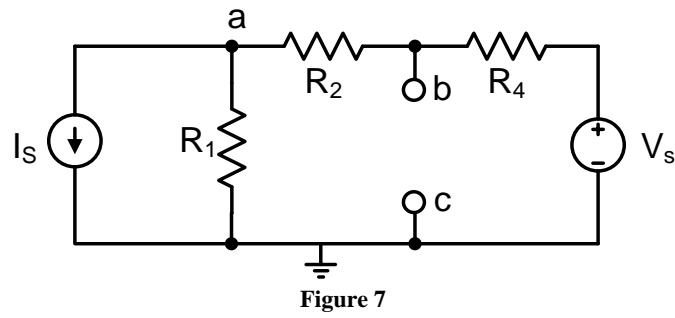
(b.i) (3 pt) **Draw** the sub-circuit when **only  $I_S$**  is activated. Then, **find  $i$**  for this sub-circuit using any technique(s) of your choice.

(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.

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

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

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



- e. (5 pt) Use your answers **from part (d)** to help determine  $i$  in Figure 6.

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



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

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

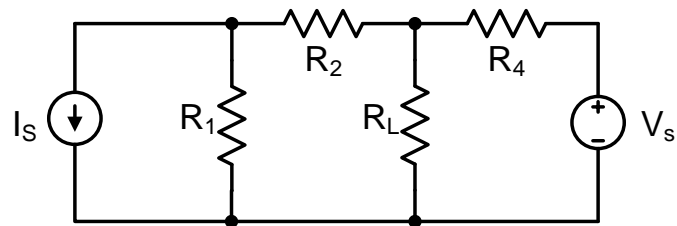


Figure 8

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

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

7. (4\* pt) In this question, you **must** use the specified techniques to solve the problem. There will be **no credit** 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  $R_5 = 11 \Omega$ .

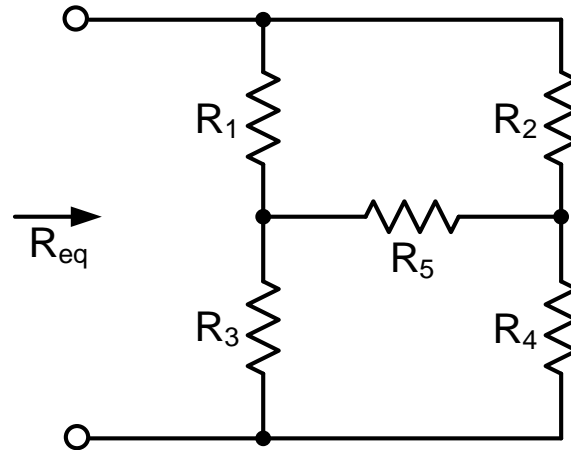


Figure 9

- a. (2 pt) Find  $R_{eq}$  using **nodal analysis**.

- b. (2 pt) Find  $R_{eq}$  using **mesh analysis**.

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