

EE2005 Electronic Devices and Circuits Test 1
Time Allowed: 90 min

Name: _____

Student Number: _____

Date: _____

Tutorial Group: _____

Attempt ALL the questions. Write down your working clearly into space provided in the test paper.
 (Total 50 marks)

1. By applying mesh current analysis for the circuit as shown in Figure 1, answer the following questions.

- How many branches and nodes are in the circuit?
- Write the mesh-current equations for i_1 , i_2 and i_3 .
- Solve for i_2 and i_3 and hence determine the voltage across the 2Ω resistor and the power dissipated by it.

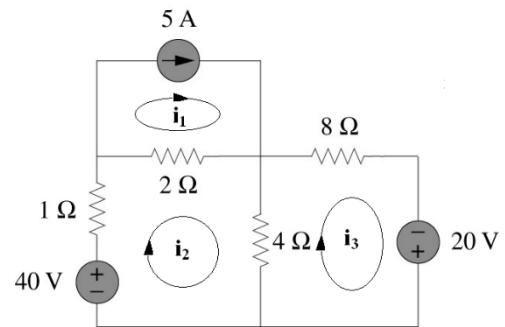


Figure 1

(15 marks)

Solution:

(a) 7 branches, 5 nodes (or 6 branches, 4 nodes)

$$(b) \quad 5 = i_1 \quad (1)$$

$$40 = -2i_1 + 7i_2 - 4i_3 \quad (2)$$

$$20 = -0i_1 - 4i_2 + 12i_3 \quad (3)$$

(c) On solving, $i_2 = 10 \text{ A}$, $i_3 = 5 \text{ A}$

$$\text{Voltage across } 2\Omega = (i_2 - i_1) \cdot 2 = 10 \text{ V}$$

$$\text{Maximum Power dissipated by } 2\Omega = V^2/R = 50 \text{ W}$$

2. Figure 2 shows a resistor network.

- Determine the equivalent resistance R_{eq} .
- When a voltage source V_s is connected across the terminal 'a' and 'b', $I_1 = 2A$, what is the value of I_2 ?
- Refer to part (b), guess whether the positive terminal of V_s is connected to node 'a' or 'b'. Justify your answer.
- Refer to part (b), determine the value of V_s .

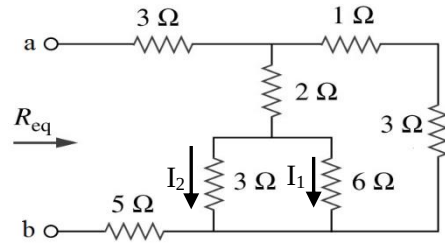


Figure 2

(15 marks)

Solution:

(a) $R_{TH} = 3 + 5 + (1+3)/(2+3/6)=10\Omega$

(b) $6 I_1 = 3 I_2 \rightarrow I_2 = (6/3)*I_1 = 4A$

(c) Since I_1 and I_2 are flowing downward, and there is no other voltage or current sources in the circuit, it is reasonable to guess the positive terminal of V_s should be connected to node "a"

(d) The current through the resistor 2Ω , $I_{2\Omega} = I_1 + I_2 = 6 A$ by KCL

The current through the resistors branch $1\Omega + 3\Omega = 6 A$

The current from the source V_s , $I_s = 6 + 6 = 12 A$ (current through 3Ω or 5Ω)

So $V_s = (R_{TH})(I_s) = (10)(12) = 120V$

3. Use source transformation technique to determine the Thevenin equivalent circuit as seen by the resistor R as shown in Figure 3.

Hence, determine the value of R for maximum power dissipation. What is the power dissipation under the above condition?

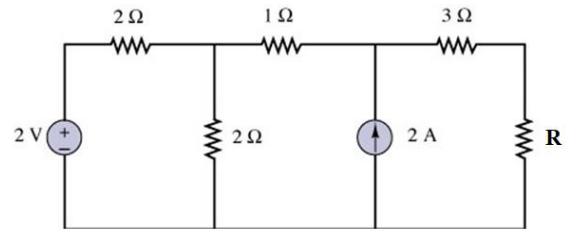


Figure 3

(10 marks)

Solution:

Must use source transformation to the answer, with the relevant sketches to show the work. Student can apply source transformation between Thevenin and Norton equivalent repeatedly until getting the final Thevenin equivalent form.

$$R_{TH} = 5\Omega$$

$$V_{TH} = 5V$$

For maximum power transfer, $R = R_{TH} = 5\Omega$

The corresponding power is given by

$$P_{max} = V_{Th}^2 / (4R_{TH}) = 1.25W$$

4. Comment with reasons whether the following statements is “TRUE” or “FALSE”. Please refer to Figure 4 wherever necessary. (10 marks)

(a) The anode of a diode is connected to the n-type semiconductor material.

False, the anode should be connected to p-type

(b) If v_D is negative, the diode is operated in the B region which is called forward biased.

False, region B is reversed biased

(c) When a diode is operated in the A region, the depletion layer is formed across the p-n junction.

False, Region A is forward biased so that no depletion layer will form

(d) The diode can be used a rectify an AC signal when it is operated at A region.

False, a diode needs to work in both region A (forward-biased) and region B (reverse biased) to carry the process

(e) A full-wave rectification configuration is more efficient than a half-wave rectification configuration because a full-wave rectification configuration can produce a DC voltage output while a half-wave rectification configuration cannot.

False, both configurations can rectify the ac signal into a dc signal.

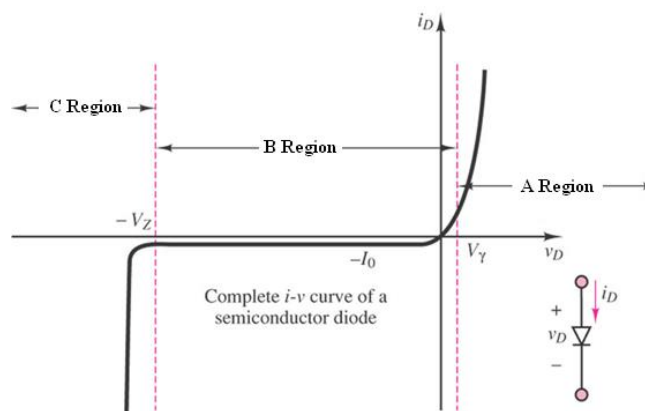


Figure 4