CITY UNIVERSITY OF HONG KONG

Test 2

Course code & title : EE1002 Principles of Electrical Engineering

Session : Semester A 2021/22

Time allowed : Two hours (one hundred and twenty minutes)

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1. Multiple Choice questions (18 MC questions carry 54 marks)
   Written questions (3 questions carry a total of 54 marks)

2. Start a new page for each written question.

3. It is an open-book examination

Materials, aids & instruments permitted to be used during the examination:

Non-programmable portable battery-operated calculator

Academic Honesty

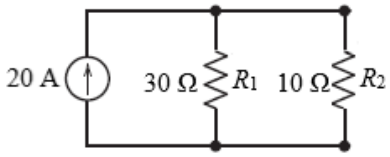
"I pledge that the answers in this exam are my own and that I will not seek or obtain an unfair advantage in producing these answers. Specifically,

- I will not plagiarize (copy without citation) from any source;
- I will not communicate or attempt to communicate with any other person during the exam; neither will I give or attempt to give assistance to another student taking the exam; and
- I will use only approved devices (e.g., calculators) and/or approved device models.
- I understand that any act of academic dishonesty can lead to disciplinary action."

Please reaffirm this honesty pledge by writing "I pledge to follow the Rules on Academic Honesty and understand that violations may lead to severe penalties" onto the "Answer Sheet" attached to this test paper.

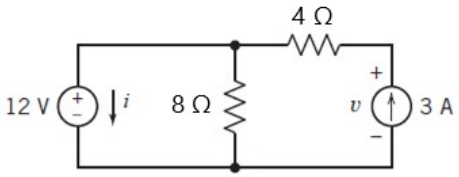
Part I: Multiple choice (Total 60 minutes; 18 questions, 3 points per question)
Please provide your answers in the attached "Answer Sheet".

1. Find the power consumed by resistors R_1 and R_2.



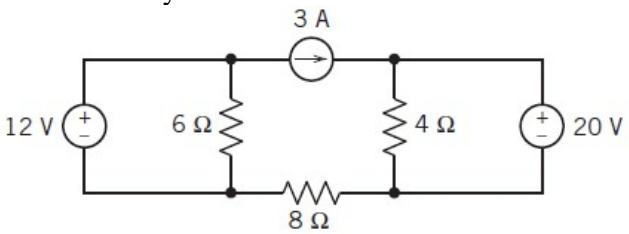
A. $P_1 = 6750\ \text{W}, P_2 = 2250\ \text{W}$
B. $P_1 = 6750\ \text{W}, P_2 = 250\ \text{W}$
C. $P_1 = 750\ \text{W}, P_2 = 2250\ \text{W}$
D. $P_1 = 750\ \text{W}, P_2 = 250\ \text{W}$

2. Find the current i and the voltage v.



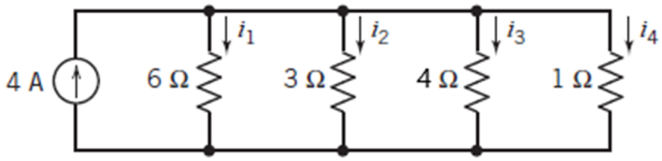
A. $i = -1.5\ A, v = 36\ \text{V}$
B. $i = 1.5\ A, v = 24\ \text{V}$
C. $i = 3\ A, v = 36\ \text{V}$
D. $i = -3\ A, v = 24\ \text{V}$

3. Determine the power absorbed by the 8 Ω resistor.



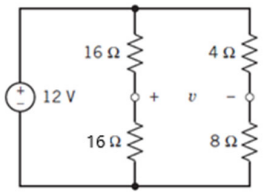
A. $P = 72\ W$
B. $P = 100\ W$
C. $P = 24\ W$
D. $P = 392\ W$

4. Rank the currents from largest to smallest.



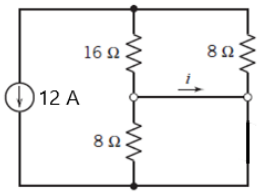
A. $i_1 > i_2 > i_3 > i_4$
B. $i_1 > i_3 > i_2 > i_4$
C. $i_2 > i_1 > i_3 > i_4$
D. $i_4 > i_2 > i_3 > i_1$

5. Find the voltage *v*.



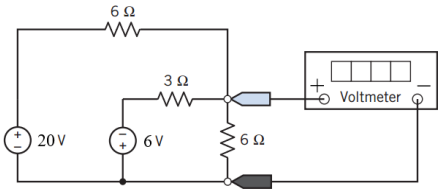
A. $v = 2\ \text{V}$
B. $v = 6\ \text{V}$
C. $v = -6\ \text{V}$
D. $v = -2\ \text{V}$

6. Find the current *i*.



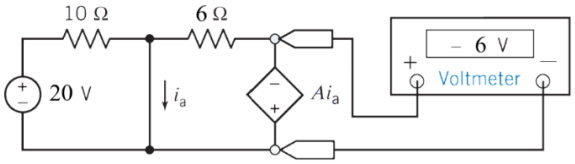
A. $i = 4\ \text{A}$
B. $i = -4\ \text{A}$
C. $i = 8\ \text{A}$
D. $i = -8\ \text{A}$

7. Determine the value of the voltage measured by the ideal voltmeter.



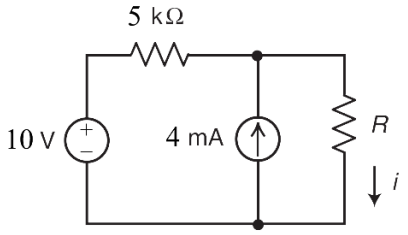
A. $v_m = -2\ V$
B. $v_m = 2\ V$
C. $v_m = -8\ V$
D. $v_m = 8\ V$

8. In the following circuit, find the value of *A* of the current controlled voltage source.



A. $A = 6$.
B. $A = -6$.
C. $A = 12$.
D. $A = -12$.

9. In the following circuit, determine the relationship between the resistance R and the resistor current i.



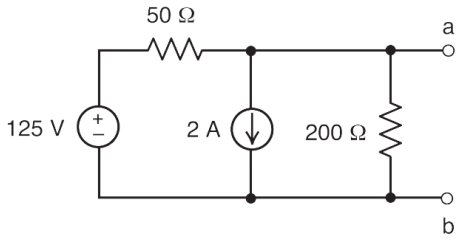
A. $i = \frac{10}{5000+R}$.

B. $i = \frac{-10}{5000+R}$.

C. $\boldsymbol{i = \frac{30}{5000+R}}$.

D. $i = \frac{-30}{5000+R}$.

10. Determine the Norton equivalent circuit for the following circuit.



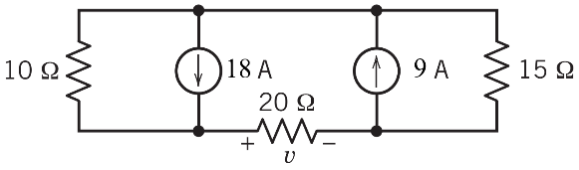
A. $\boldsymbol{R_N = 40\ \Omega, I_N = 0.5\ A}$

B. $R_N = 40\ \Omega, I_N = 4.5\ A$

C. $R_N = 250\ \Omega, I_N = 0.5\ A$

D. $R_N = 250\ \Omega, I_N = 4.5\ A$

11. Find the voltage v for the following circuit.



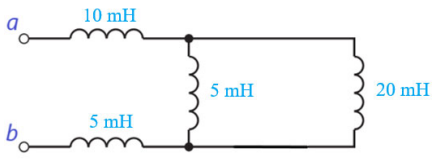
A. $v = -20\ V$

B. $v = 20\ V$

C. $v = -140\ V$

D. $\boldsymbol{v = 140\ V}$

12. For the four inductors connected as shown on the following circuit, find the equivalent inductance L_{ab}.



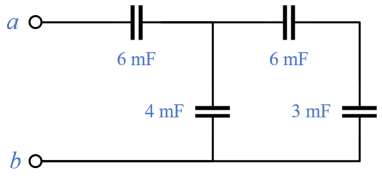
A. 19 mH

B. $\frac{12}{7}$ mH

C. $\frac{5}{2}$ mH

D. 30 mH

13. For the four capacitors connected as shown on the following circuit, find the equivalent capacitance C_{ab}.



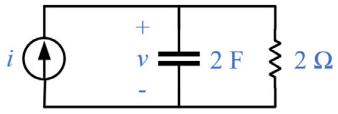
A. 19 mF

B. $\frac{114}{13}$ mF

C. 3 mF

D. $\frac{36}{13}$ mF

14. Find i for the following circuit if $v = 5(1 - 2e^{-2t})$ V.
[Hint: You may use the KCL to solve the problem.]



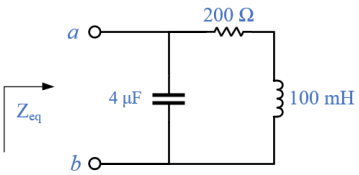
A. $2.5 + 5e^{-2t}$ A

B. $2.5 + 35e^{-2t}$ A

C. $2.5 - 45e^{-2t}$ A

D. $5 - 10e^{-2t}$ A

15. Determine the equivalent impedance Z_{eq} of the following circuit at the frequency $\omega = 1000$ rad/s.



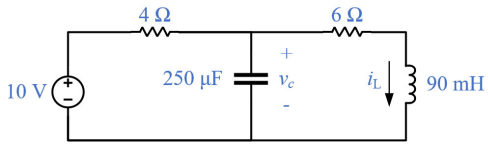
A. $0.0018\angle 26.6°\ \Omega$

B. $0.004\angle 90°\ \Omega$

C. $0.25\angle -89.9°\ \Omega$

D. $223.6\angle -26.6°\ \Omega$

16. Under steady-state dc conditions (No current and voltage change), find i_L and v_c of the following circuit.



A. $i_L = 1\ \text{A}, v_c = 6\ \text{V}$

B. $i_L = 4\ \text{A}, v_c = 6\ \text{V}$

C. $i_L = 0.125\ \text{A}, v_c = 4\ \text{V}$

D. $i_L = 0.125\ \text{A}, v_c = 3.7\ \text{V}$

17. Determine the capacitance of a capacitor when the voltage across it is $v(t) = 12\cos(500t - 45°)$ **V** and the current is $i(t) = 6\cos(500t + 45°)$ **mA**.

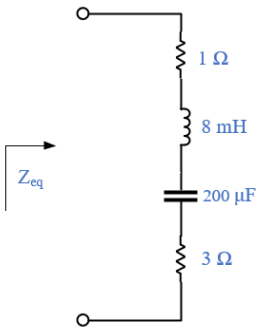
A. $C = 1$ uF

B. $C = 1$ mF

C. $C = 1.8$ mF

D. $C = 0.8$ F

18. When $\omega = 1000$ rad/s, find the impedance Z_{eq} seen across the terminals.



A. $2\angle -30°\ \Omega$

B. $3.5\ \Omega$

C. $4\angle 45°\ \Omega$

D. $5\angle 36.8°\ \Omega$

Part II: Written Questions (Total 60 minutes; 3 questions)

Question 1 **(15 points)**

The circuit *a* has been divided into two parts. The right-hand part has been replaced with an equivalent circuit as shown in circuit *b*.

(a) Determine the value of the resistance *R*. **(3 points)**

(b) If the equivalent *R* is removed in circuit *b*, find the Thevenin equivalent circuit at terminals *m*-*n*. **(4 points)**

(c) Find the current *i* and the voltage *v* shown in circuit *b*. **(4 points)**

(d) Find the current i_2 shown in circuit *a*. **(4 points)**

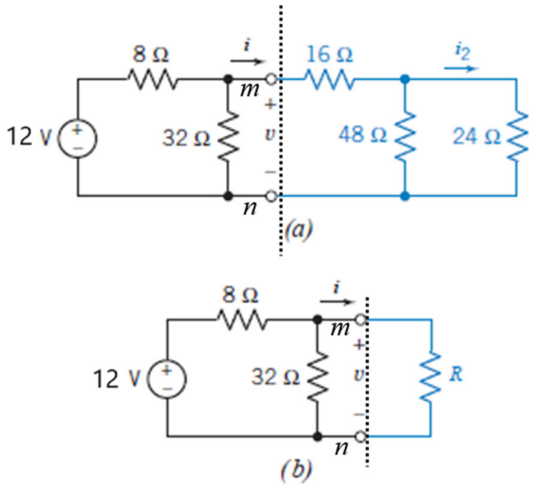


Fig. Q1

Question 2 **(18 points)**

The voltages v_2, v_3, and v_4 for the following circuit in Fig. Q2 are: $v_2 = 24$ V, $v_3 = 6$ V, and $v_4 = 3$ V. Determine the values of the following:

(a) The value of A of the voltage controlled voltage source. **(3 points)**

(b) The resistance R_4. **(3 points)**

(c) The power received by resistor R_a. **(3 points)**

(d) The currents i_b and i_c. **(6 points)**

(e) The voltage v_1 of the voltage source. **(3 points)**

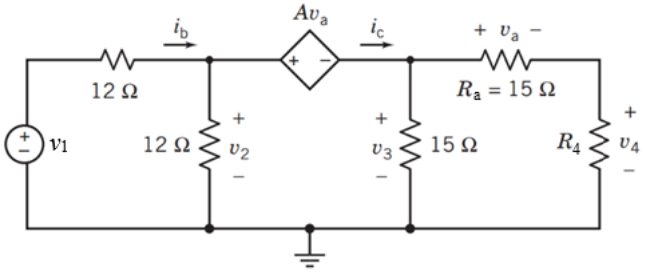


Fig. Q2

Question 3 **(21 points)**

(A) Fig. Q3(a) shows a dc circuit. Find the three mesh currents i_1, i_2, and i_3. **(9 points)**

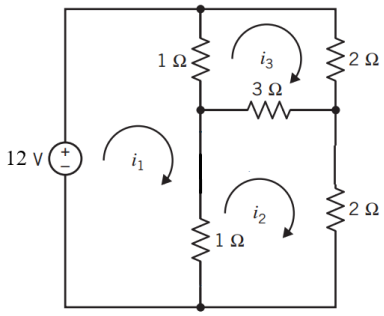


Fig. Q3(a)

(B) Another current source is introduced as shown in Fig. Q3(b), find the three mesh currents i_1, i_2, and i_3. **(12 points)**

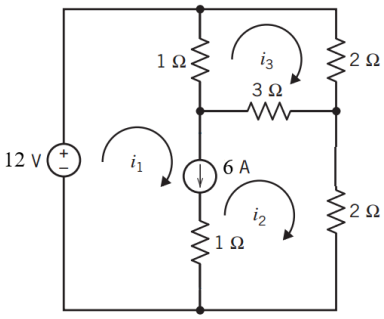


Fig. Q3(b)

Long question solutions

Q1 Solution:

(a) $R = 16 + \frac{48\times24}{48+24} = 32\ \Omega$

(b) $V_T = 12 \times \frac{32}{32+8} = 9.6\ V,\ R_T = \frac{32\times8}{32+8} = 6.4\ \Omega$

(c) $v = \frac{\frac{32}{2}}{\frac{32}{2}+8} \times 12V = 8\ V,\ i = \frac{8}{32} = \frac{1}{4}\ A$

(d) $i_2 = \frac{48}{48+24} \cdot i = \frac{1}{6}\ A$

Q2 Solution:

Given the node voltages

$$v_2 = 24\ \text{V},\ v_3 = 6\ \text{V, and}\ v_4 = 3\ \text{V}$$

(a) $$A = \frac{Av_a}{v_a} = \frac{24-6}{3} = 6$$

(b) $$R_5 * \left(\frac{v_a}{R_4}\right) = R_5 * \left(\frac{v_3-v_4}{R_4}\right) = v_4 \quad R_5 * \left(\frac{6-3}{15}\right) = 3 \quad R_5 = 15\ \Omega$$

(c)

$$p_4 = \frac{v_a^2}{R_4} = \frac{(6-3)^2}{15} = 0.6\ \text{W}$$

(d)

$$i_c = \frac{v_3}{15} + \frac{v_3}{15+15} = \frac{6}{15} + \frac{6}{30} = 0.6\ \text{A}$$

$$i_b = i_c + \frac{v_2}{12} = 0.6 + \frac{24}{12} = 2.6\ \text{A}$$

(e)

$$U = v_2 + 12 * i_b = 24 + 31.2 = 55.2\ V$$

Q3 Solution:

(A)Mesh 1: Using KVL, obtain

$$12 = 1*(i_1-i_3)+1*(i_1-i_2) \quad ①$$

Mesh 2:

$$0 = 1*(i_2-i_1)+3*(i_2-i_3)+2*i_2 \quad ②$$

Mesh 3:

$$0 = 1*(i_3-i_1)+3*(i_3-i_2)+2*i_3 \quad ③$$

Based on ① ② ③, obtain

$$2i_1-i_2-i_3 = 12$$
$$-i_1+6i_2-3i_3 = 0$$
$$-i_1-3i_2+6i_3 = 0$$

Then, $i_1 = 9\text{A}$, $i_2 = 3\text{A}$, $i_3 = 3\text{A}$.

(B)Supermesh 1 2: Using KVL, obtain

$$12 = 1*(i_1-i_3)+3*(i_2-i_3)+2i_2 \quad ④$$

Current source:

$$i_1-i_2 = 6 \quad ⑤$$

Mesh 3:

$$0 = 1*(i_3-i_1)+3*(i_3-i_2)+2*i_3 \quad ⑥$$

Then, $i_1 = 9\text{A}$, $i_2 = 3\text{A}$, $i_3 = 3\text{A}$.