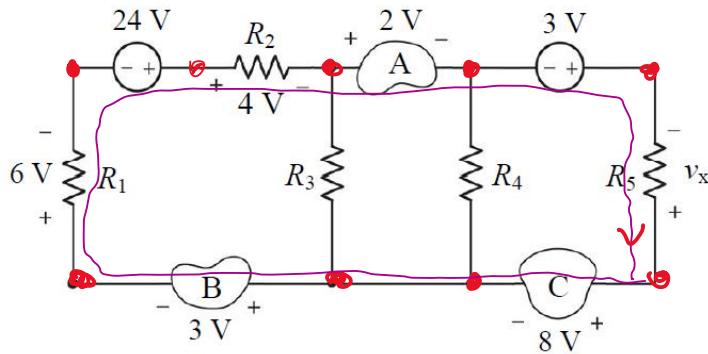# BLM1032 – Circuit Theory
Short Exam 1 – 08/April/2021

Upload your answer as a single PDF file at max. 5MB of size. There are total of 5 (five questions).

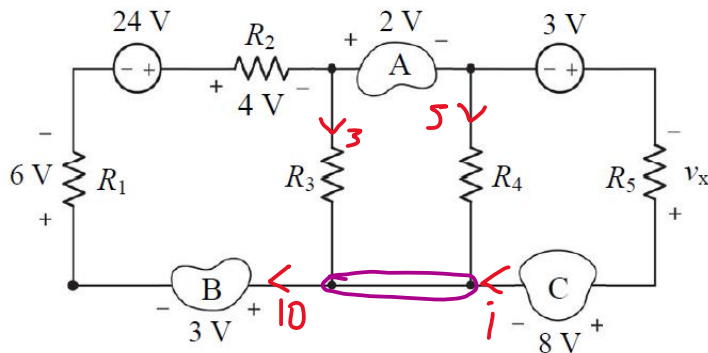**Q 1:** Parts (a)–(d) refer to the circuit given below.

(a) How many nodes exist in this circuit?

There are total of 8 nodes.

(b) Determine the voltage v_x. (3)

walking through the given loop: $8+3+6-24+4+2-3-v_x=0$
$$v_x = -4V$$

(c) If a current of 10 A flows through element B to the left, 3 A flows through $R3$ downward, and 5 A flows through $R4$ downward, how much current flows through resistor $R5$? (3)

writing KCL for the node
$$3+5+i=10$$
$$i=2A$$

(d) How much electrical *energy* is absorbed by resistor $R5$ in 7 seconds? (2)

$$E = t \cdot v \cdot i = 7 \cdot 2 \cdot (-4) = 56 \text{ Joules}$$

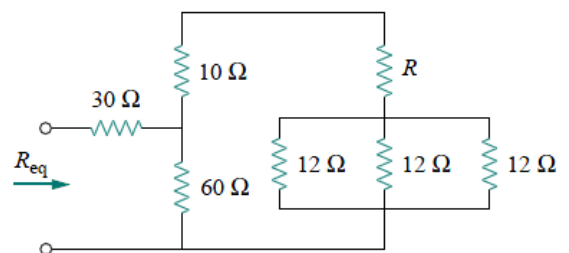**Q 2:** If $R_{eq} = 50\ \Omega$ in the circuit in below Figure, find R. (6)

$$R_{eq} = \left(\left((12 // 12 // 12) + R + 10\right) // 60\right) + 30$$

$$50 = \left((4 + R + 10) // 60\right) + 30$$

$$20 = (14+R) // 60$$

$$\frac{1}{20} = \frac{1}{14+R} + \frac{1}{60}$$
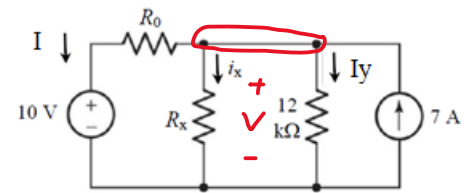
$$14 + R = 30 \implies R = 16$$

Q 3: For the circuit below, the voltage source delivers 50 W. If the value of the current i_x is 9 A, determine the value of the resistance R_x. (8)

$$= -50W$$

$$t. \ 10 = -50 \Rightarrow I = -5A$$

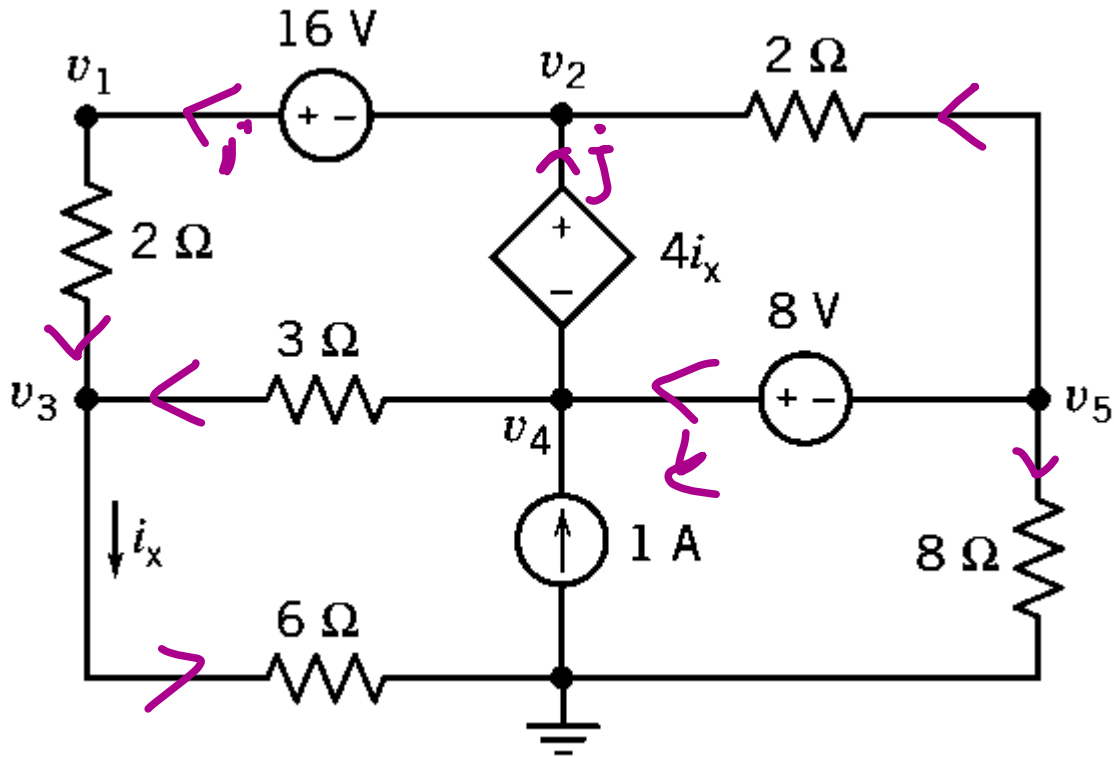$$I + ix + Iy = 7 \Rightarrow -5 + 9 + Iy = 7 \Rightarrow Iy = 3A$$

$$V = 3.12k$$

$$Rx = \frac{U}{ix} = \frac{3.12k}{9} = 4k\Omega$$

Q 4: Write down the equation system fort he given circuit using the node analysis method.

16 V

v_1

v_2

2 Ω

2 Ω

$4i_x$

8 V

3 Ω

v_3

v_5

v_4

i_x

1 A

8 Ω

6 Ω

$$V_1: \quad \frac{V_1 - V_3}{2} = i \qquad\qquad V_2: \quad \frac{V_5 - V_2}{2} + J - i = 0$$

$$V_3: \quad \frac{V_4 - V_3}{3} + \frac{V_1 - V_3}{2} - \frac{V_3}{6} = 0 \qquad V_4: \quad 1 + k - j - \frac{V_4 - V_3}{3} = 0$$

$$V_5: \quad \frac{V_5}{8} + k + \frac{V_5 - V_2}{2} = 0 \qquad\qquad i_x = \frac{V_3}{6} \qquad\qquad V_4 = V_5 + 8$$

$$V_1 = V_2 + 16 \qquad\qquad V_2 = V_4 + 4 i_x$$

$$V_1, V_2, V_3, V_4, V_5, \; i, j, k, i_x$$

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$①\ V_1\quad -V_3\qquad\qquad -2i\qquad\qquad =0$

$②\quad -V_2\quad +V_5\ -2i+2j\qquad =0$

$③\ 3V_1\quad -6V_3+2V_4\qquad\qquad =0$

$④\qquad\quad V_3-V_4\quad -3j+3k\ =-3$

$⑤\quad -4V_2\qquad +5j\qquad +8k\ =0$

$⑥\qquad\quad V_3\qquad\qquad -6ix=0$

$⑦\qquad\quad V_4\ -V_5\qquad\qquad =8$

$⑧\qquad\ V_2\qquad\qquad\qquad =16$
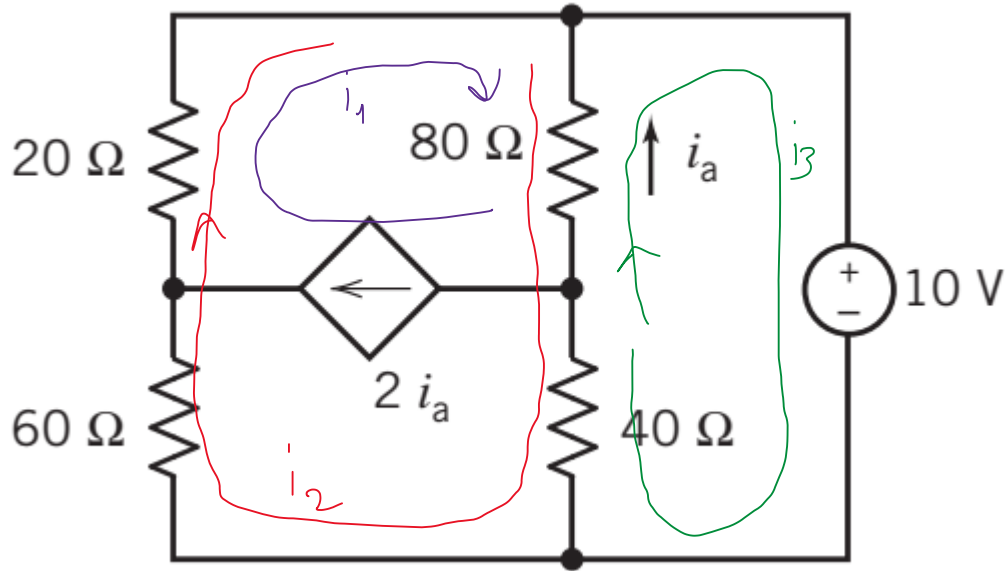
$⑨\quad -V_2\ +V_4\qquad\qquad +4ix=0$

$$\begin{bmatrix} 1 & 0 & -1 & 0 & 0 & -2 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 1 & -2 & 2 & 0 & 0 \\ 3 & 0 & -6 & 2 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & -1 & 0 & 0 & -3 & 3 & 0 \\ 0 & -4 & 0 & 0 & 5 & 0 & 0 & 8 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & -6 \\ 0 & 0 & 0 & 1 & -1 & 0 & 0 & 0 & 0 \\ 1 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 1 & 0 & 0 & 0 & 0 & 4 \end{bmatrix}^{-1} \begin{bmatrix} 0 \\ 0 \\ 0 \\ -3 \\ 0 \\ 0 \\ 8 \\ 16 \\ 0 \end{bmatrix} \Rightarrow$$

$V_1=24V$

$U_2=8V$

$V_3=12V$

$U_4=0V$

$V_5=-8V$

$i=6A$

$j=14A$

$k=9A$

$ix=2A$

Q 5: Write down the equation system fort he given circuit using the mesh analysis method.

(1) $i_1 = 2 i_a$

(2) $60 i_2 + 20(i_1 + i_2) + 80(i_1 + i_2 - i_3) + 60(i_2 - i_3) = 0$

(3) $40(i_3 - i_2) + 80(i_3 - i_2 - i_1) + 10 = 0$

(4) $i_a = i_3 - i_2 - i_1$

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$$
\begin{bmatrix}
1 & 0 & 0 & -2 \\
100 & 200 & -160 & 0 \\
-80 & -120 & 120 & 0 \\
1 & 1 & -1 & 1
\end{bmatrix}
\begin{bmatrix}
i_1 \\
i_2 \\
i_3 \\
i_a
\end{bmatrix}
=
\begin{bmatrix}
0 \\
0 \\
-10 \\
0
\end{bmatrix}
$$

$i_1 = -0,1 A$
$i_2 = -0,1 A$
$i_3 = -0,25 A$
$i_a = -0.05 A$