ECE 2040 Exam 1
Fall 2024

Name _____

General Instructions instructions:

- Exam is closed book / closed notes other than the one-page of handwritten notes.
- Choose the best possible answer available in all cases.
- Blank scratch paper is allowed

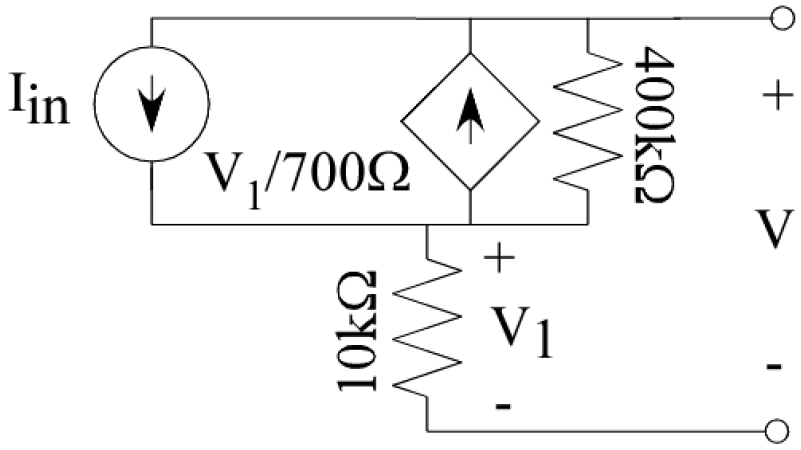
_____ Part I: Objective Questions

_____ Part II: Open Response Question
(In the following pages)

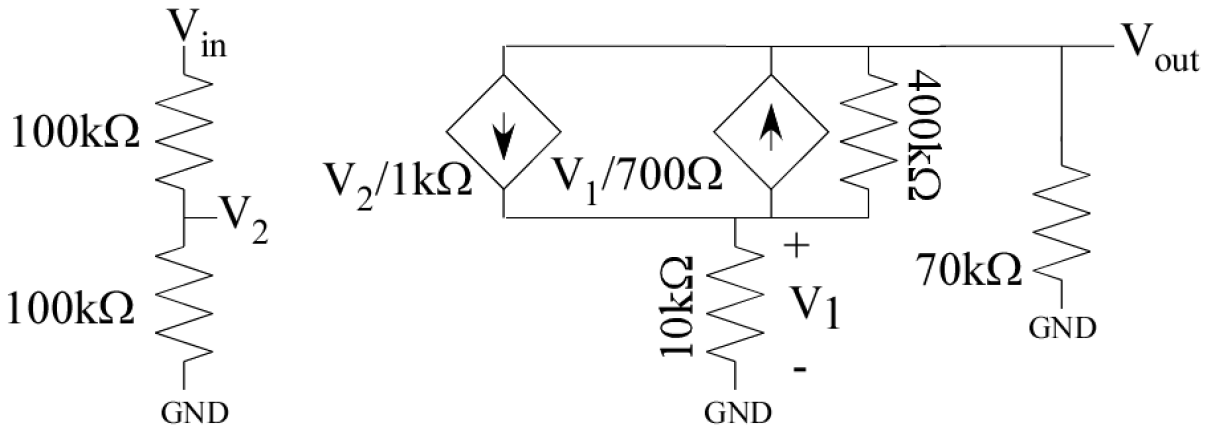
_____ Final Score

Part II: Open Response Question (20 points)

Start with creating the one-port Norton model for the following circuit, where I_{in} is a current source of a fixed value.



Using the Norton model you developed, solve for the output voltage (Vout) as a function of the input voltage (Vin), as well as the effective resistance at the output node, and creating a Thevenin representation for this circuit.



ECE 2040 Exam 1
Fall 2024
Part I: Objective Questions

Name _____

Each question is worth 4 points.
All of your answers need to be on this sheet.
Only the final answers, as indicated by the question, will be considered correct for each question.

Choose the best possible answer available in all cases.

1. _____ 11. _____

2. _____ 12. _____

3. _____ 13. _____

4. _____ 14. _____

5. _____ 15. _____

6. _____ 16. _____

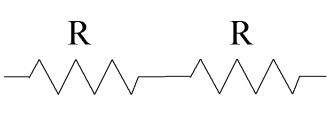
7. _____ 17. _____

8. _____ 18. _____

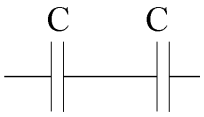
9. _____ 19. _____

10. _____ 20. _____

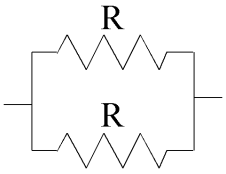
Use the following circuit diagrams for the following questions: (R = 10kΩ, C = 1nF)



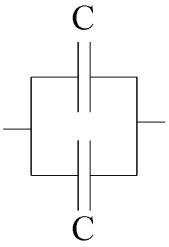
(1)



(3)



(2)



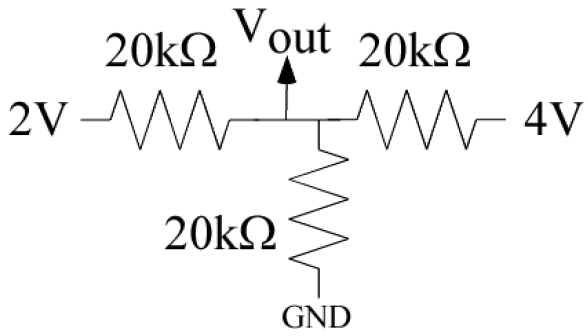
(4)

1. For the elements in (1) above, the equivalent resistance is
a. 2.5kΩ
b. 5kΩ
c. 10kΩ
d. 20kΩ
e. 40kΩ

2. For the elements in (3) above, the equivalent capacitance is
a. 0.25nF
b. 0.5nF
c. 1nF
d. 2nF
e. 4nF

3. For the elements in (4) above, the equivalent capacitance is
a. 0.25nF
b. 0.5nF
c. 1nF
d. 2nF
e. 4nF

Using the following circuit



4. What is the correct Node matrix formulation?

a. $\left[60k\Omega\right] V_{out} = \left[\frac{2V}{20k\Omega} + \frac{4V}{20k\Omega}\right]$

b. V_{out} = 1V

c. $\left[\frac{3}{20k\Omega}\right] V_{out} = \left[\frac{2V}{20k\Omega} + \frac{4V}{20k\Omega}\right]$

d. $\left[\frac{1}{20k\Omega}\right] V_{out} = \left[\frac{2V}{20k\Omega} + \frac{4V}{20k\Omega}\right]$

e. V_{out} = 3V

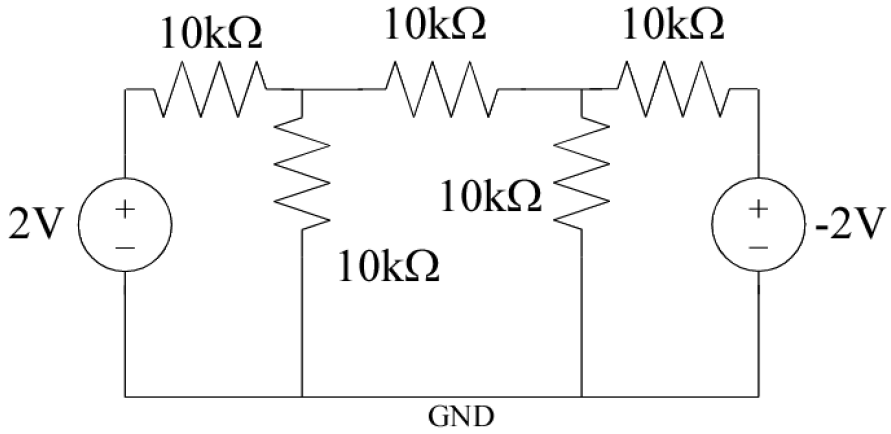
5. What is the correct Mesh matrix formulation assuming two clockwise loops?

a. $\begin{bmatrix} 40k\Omega & 20k\Omega \\ 20k\Omega & 40k\Omega \end{bmatrix} \begin{bmatrix} J_1 \\ J_2 \end{bmatrix} = \begin{bmatrix} 2V \\ -4V \end{bmatrix}$

b. $\begin{bmatrix} 40k\Omega & -20k\Omega \\ -20k\Omega & 40k\Omega \end{bmatrix} \begin{bmatrix} J_1 \\ J_2 \end{bmatrix} = \begin{bmatrix} 2V \\ -4V \end{bmatrix}$

c. $\begin{bmatrix} 40k\Omega & 20k\Omega \\ 20k\Omega & 40k\Omega \end{bmatrix} \begin{bmatrix} J_1 \\ J_2 \end{bmatrix} = \begin{bmatrix} 2V \\ 4V \end{bmatrix}$

d. $\begin{bmatrix} 40k\Omega & -20k\Omega \\ -20k\Omega & 40k\Omega \end{bmatrix} \begin{bmatrix} J_1 \\ J_2 \end{bmatrix} = \begin{bmatrix} 2V \\ -4V \end{bmatrix}$



6. What is the correct Node matrix formulation?

a. $\begin{bmatrix} \frac{2}{10k\Omega} & -\frac{1}{10k\Omega} \\ -\frac{1}{10k\Omega} & \frac{2}{10k\Omega} \end{bmatrix} \begin{bmatrix} e_1 \\ e_2 \end{bmatrix} = \begin{bmatrix} 2V \\ -2V \end{bmatrix}$

b. $\begin{bmatrix} \frac{3}{10k\Omega} & \frac{1}{10k\Omega} \\ \frac{1}{10k\Omega} & \frac{3}{10k\Omega} \end{bmatrix} \begin{bmatrix} e_1 \\ e_2 \end{bmatrix} = \begin{bmatrix} 2V \\ -2V \end{bmatrix}$

c. $\begin{bmatrix} \frac{2}{10k\Omega} & \frac{1}{10k\Omega} \\ \frac{1}{10k\Omega} & \frac{2}{10k\Omega} \end{bmatrix} \begin{bmatrix} e_1 \\ e_2 \end{bmatrix} = \begin{bmatrix} 2V \\ -2V \end{bmatrix}$

d. $\begin{bmatrix} \frac{3}{10k\Omega} & -\frac{1}{10k\Omega} \\ -\frac{1}{10k\Omega} & \frac{3}{10k\Omega} \end{bmatrix} \begin{bmatrix} e_1 \\ e_2 \end{bmatrix} = \begin{bmatrix} 2V \\ -2V \end{bmatrix}$

e. $\begin{bmatrix} \frac{1}{10k\Omega} & -\frac{1}{10k\Omega} \\ -\frac{1}{10k\Omega} & \frac{1}{10k\Omega} \end{bmatrix} \begin{bmatrix} e_1 \\ e_2 \end{bmatrix} = \begin{bmatrix} 2V \\ -2V \end{bmatrix}$

7. What is the correct Mesh matrix formulation assuming three clockwise loops?

a. $\begin{bmatrix} 20k\Omega & -10k\Omega & 0 \\ -10k\Omega & 30k\Omega & -10k\Omega \\ 0 & -10k\Omega & 20k\Omega \end{bmatrix} \begin{bmatrix} J_1 \\ J_2 \\ J_3 \end{bmatrix} = \begin{bmatrix} 2V \\ 0 \\ 2V \end{bmatrix}$

b. $\begin{bmatrix} 20k\Omega & -20k\Omega & 0 \\ -20k\Omega & 20k\Omega & -10k\Omega \\ 0 & -10k\Omega & 20k\Omega \end{bmatrix} \begin{bmatrix} J_1 \\ J_2 \\ J_3 \end{bmatrix} = \begin{bmatrix} 2V \\ 0 \\ 2V \end{bmatrix}$

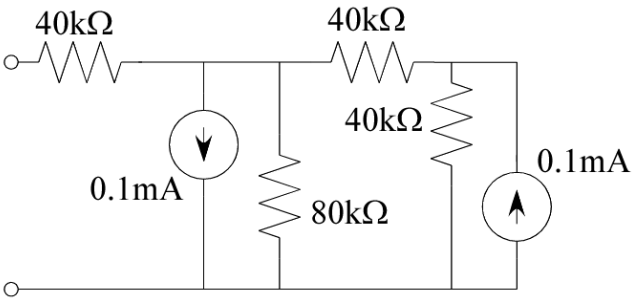
c. $\begin{bmatrix} 20k\Omega & -20k\Omega & 0 \\ -20k\Omega & 30k\Omega & -10k\Omega \\ 0 & -10k\Omega & 20k\Omega \end{bmatrix} \begin{bmatrix} J_1 \\ J_2 \\ J_3 \end{bmatrix} = \begin{bmatrix} 2V \\ 0 \\ 2V \end{bmatrix}$

d. $\begin{bmatrix} 20k\Omega & -20k\Omega & 0 \\ -20k\Omega & 30k\Omega & -20k\Omega \\ 0 & -20k\Omega & 20k\Omega \end{bmatrix} \begin{bmatrix} J_1 \\ J_2 \\ J_3 \end{bmatrix} = \begin{bmatrix} 2V \\ 0 \\ 2V \end{bmatrix}$

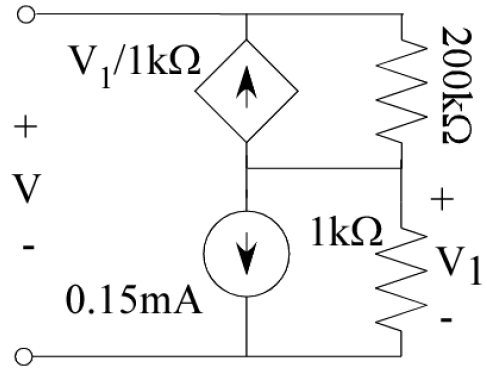
e. $\begin{bmatrix} 20k\Omega & -20k\Omega & 0 \\ -20k\Omega & 20k\Omega & -20k\Omega \\ 0 & -20k\Omega & 20k\Omega \end{bmatrix} \begin{bmatrix} J_1 \\ J_2 \\ J_3 \end{bmatrix} = \begin{bmatrix} 2V \\ 0 \\ 2V \end{bmatrix}$

Given the following six circuits (and choosing the closest right answer),

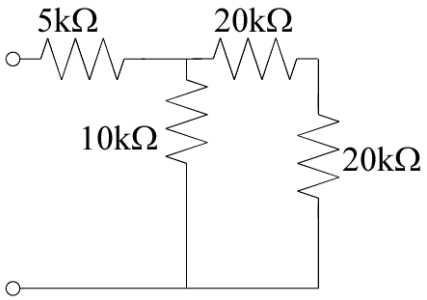
A:



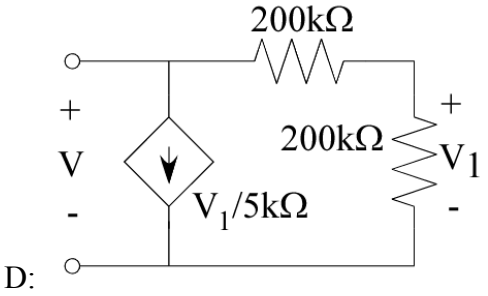
B:



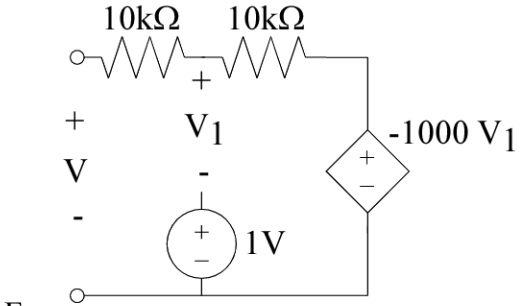
C:



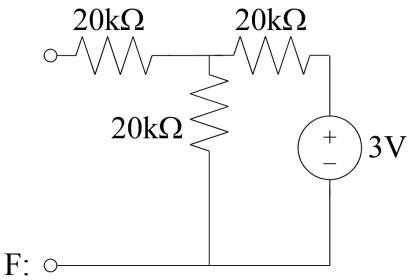
D:



E:



F:



Which circuits have the resistance for the Thevenin equivalent circuit?

8. >300kΩ 9. 80kΩ 10. 9kΩ 11. 30kΩ

Which two circuits have zero voltage source for the Thevenin equivalent circuit?

12. Has no dependent Sources
13. Has a dependent source

Which circuits have the voltage source value for the Thevenin equivalent circuit?

14. -2V 15. 20 V 16. 1.5V

Which circuits have current source value for the Norton equivalent circuit?

17. 0.1mA 18. -25μA 19. 50μA

20. True (T) / False (F): The resistance for the Thevenin equivalent circuit is equal to the resistance for the Norton equivalent circuit.