

**C - Circuit Lab C - Rickards Invitational Div. C - 12-05-2020**

Units are required in all cases unless stated otherwise. A margin of error of ~5% will be allowed, however individual questions may be treated differently. Good luck!

1. (1.00 pts) Gustav Kirchhoff proved the moon contained sodium.

☐ True ☒ False

2. (1.00 pts) Electric monopoles have been observed:

☒ True ☐ False

3. (1.00 pts) Magnetic monopoles have been observed:

☐ True ☒ False

4. (1.00 pts) Both NPN and PNP transistors exist

☒ True ☐ False

5. (1.00 pts) A generator is any machine that converts thermal energy into electrical energy.

☐ True ☒ False

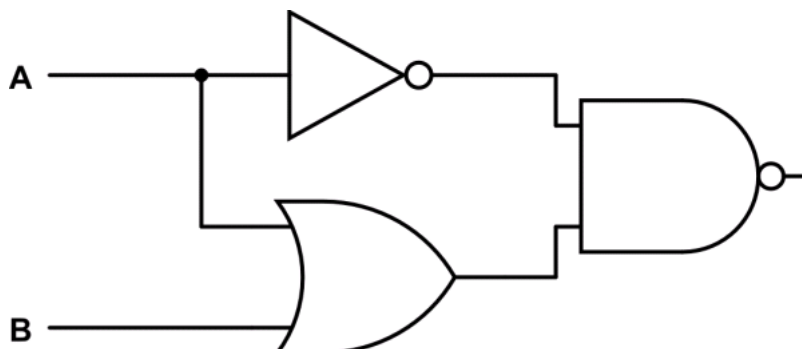
6. (1.00 pts) In a two-phase alternator generator, the two voltages are independent of each other.

☒ True ☐ False

7. (1.00 pts) One Ampere of current is equal to one electron passing a point every one second.

☐ True ☒ False

8. (2.00 pts) What is the output of the logic diagram if A is True and B is False?



☒ True ☐ False

**9. (3.00 pts)** Compared to the other 3 fundamental forces, the relative strength of the electromagnetic force is considered the \_\_\_\_ strongest.

- ☐ A) 1st
- ☒ B) 2nd
- ☐ C) 3rd
- ☐ D) 4th

**10. (3.00 pts)** What type of switch do 3-way switches make use of?

- ☐ A) SPST
- ☒ B) SPDT
- ☐ C) DPST
- ☐ D) DPDT

**11. (3.00 pts)** Which of the following is not a type of magnetism?

- ☐ A) Diamagnetism
- ☒ B) Anitdiamagnetism
- ☐ C) Ferrimagnetism
- ☐ D) Antiferromagnetism

**12. (3.00 pts)** Which of the following is NOT one of Maxwell's Equations?

- ☐ A) Gauss's Law for Electricity
- ☐ B) Gauss's Law for Magnetism
- ☐ C) Faraday's Law of Induction
- ☒ D) Coulomb's Law

**13. (3.00 pts)** Which of the following is not an effect that causes charge separation?

- ☐ A) Piezoelectric
- ☒ B) Photoelectric
- ☐ C) Pyroelectric
- ☐ D) Triboelectric

**14. (3.00 pts)** What is the effective resistance to AC current called?

- ☒ A) Impedance
- ☐ B) Reflectance

- ☐ C) Reactance
- ☐ D) Radiance

**15. (3.00 pts)** If the time constant of a circuit is 5 seconds, what is the cutoff frequency?

- ☐ A) 0.2 Hz
- ☐ B) 0.064 Hz
- ☒ C) 0.0318 Hz
- ☐ D) 15.7 Hz

**16. (2.00 pts)** In SI base units, what is the unit of conductance?

- ☐ A)  $s^{-3} \cdot A^{-2} \cdot m^2 \cdot kg^1$
- ☒ B)  $s^3 \cdot A^2 \cdot m^{-2} \cdot kg^{-1}$
- ☐ C)  $s^4 \cdot A^2 \cdot m^{-2} \cdot kg^{-1}$
- ☐ D)  $s^{-3} \cdot A^{-1} \cdot m^2 \cdot kg^1$
- ☐ E)  $s^1 \cdot A^1 \cdot m^1 \cdot kg^1$

**17. (3.00 pts)** Which of the following is NOT a type of DC motor?

- ☐ A) Shunt
- ☒ B) Temporary Magnet
- ☐ C) Series
- ☐ D) Compound

**18. (3.00 pts)** The process of current heating a conductor as it passes through is known as?

- ☐ A) Peltier Effect
- ☐ B) Electron heating
- ☒ C) Joule heating
- ☐ D) Seebeck Effect

**19. (2.00 pts)** If a fuse burns out, but a voltage is applied that is greater than the voltage rating of the fuse, what occurs?

- ☐ A) Ionizing
- ☐ B) Inducting
- ☒ C) Arcing
- ☐ D) Burning

**20. (3.00 pts)** Which of the following is an advantage of AC generators?

- ☐ A) Shielding from radiation is not necessary

- ☒ B) Less maintenance is generally required
- ☐ C) Output voltage can be smoothed by arranging coils around the armature
- ☐ D) Wide ranges of operating conditions can be obtained

**21. (3.00 pts)** An ideal op-amp does NOT have which of the following qualities?

- ☐ A) 0 current into or out of the positive input terminal
- ☐ B) 0 current into or out of the negative input terminal
- ☐ C) The same voltage at the two input terminals
- ☒ D) 0 current into or out of the output terminal

**22. (3.00 pts)** What is the capacitance of a disc with radius  $r = 1\text{m}$ ?

- ☐ A)  $3.5 \times 10^{-9}$
- ☐ B)  $7.1 \times 10^{-9}$
- ☒ C)  $7.1 \times 10^{-11}$
- ☐ D)  $3.5 \times 10^{-11}$

**23. (3.00 pts)** Which of the following cannot be used to create a Red LED?

- ☐ A) AlGaAs
- ☐ B) GaP
- ☒ C) GaN
- ☐ D) AlGaInP

**24. (3.00 pts)** Who discovered that electric potential and charge are proportional? (Last name only)

Volta

**25. (3.00 pts)** Who was the first scientist to prove the existence of electromagnetic waves? (Last name only)

Hertz

**26. (3.00 pts)** Who coined the term black-body radiation? (Last name only)

Kirchhoff

**27. (3.00 pts)** Who discovered magnetism could affect rays of light? (Last name only)

Faraday

**28. (3.00 pts)** Who discovered the inverse relationship between electric charges and distance-squared? (Last name only)

**29. (4.00 pts)** What is  $108 \oplus 57$ ? ( $\oplus$  is the boolean operator XOR)

**30. (3.00 pts)** What is the full first name of the person who the SI unit of charge is named after?

**31. (3.00 pts)** In superconductors, electrons travel in \_\_\_\_\_ pairs.

**32. (4.00 pts)** In a PN-junction, while the N-type semiconductor is doped with electrons, what is the P-type semiconductor doped with?

**33. (4.00 pts)** Simplify the boolean expression:  $(A' + B) * B + (C * B') * (A + C)$

**34. (3.00 pts)** A resistor with the following bands would have what resistance? (Units not required, answer in Ohms)

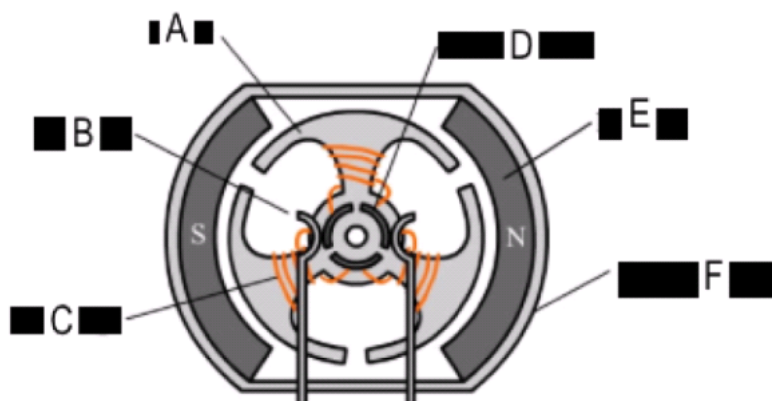
Red, Blue, Orange, Gold

**35. (6.00 pts)** The Neel temperature is the point above which \_\_\_\_\_ materials will lose those properties and gain \_\_\_\_\_ properties instead.

**36. (3.00 pts)** What type of diode has negative resistance and is also known as an Esaki diode?

**37. (6.00 pts)** Label the parts of the brushed motor. For this question, answer A, B, and C. For the next, answer D, E, and F.

### Typical Brushed Motor in Cross-section



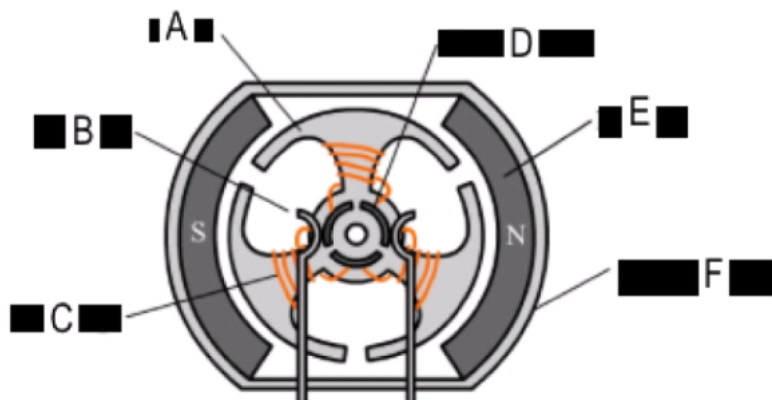
Rotor

Brushes

Winding

38. (6.00 pts) Label the parts of the brushed motor. For this question, answer D, E, and F.

### Typical Brushed Motor in Cross-section



Commutator

Magnet

Stator

39. (6.00 pts)

In a balanced Wheatstone bridge, the resistors on the left side of the bridge are 100 Ohms and 200 Ohms. If one of the resistors on the right branch is 500 Ohms, what are the possible values for the last resistor? (Units not necessary)

250

1000

40. (5.00 pts)

A point charge of  $1.8 \times 10^{-7} \text{ C}$  is placed in a vacuum. 12 mm away from the first point charge, a second point charge of  $-4.2 \times 10^{-8} \text{ C}$  is placed in the vacuum. What is the magnitude of the force between the charges? (Answer to two decimals)

0.47 N

41. (4.00 pts)

A wire carries 10 mA of current through a magnetic field of strength 2T. If there is an angle of 30 degrees between the wire and the magnetic field, what is the force on a 10 cm long section of the wire? (Answer to the nearest whole number in mN)

1 mN

42. (4.00 pts)  
A transformer has 30 turns on its primary coil and 50 turns on its secondary coil. If the voltage out is 100 V, what is the voltage in? (Answer to the nearest whole number)

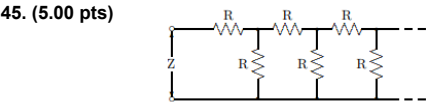
60 V

43. (6.00 pts)  
An NTC thermistor has a resistance of 100 Ohms at 300 Kelvin and 125 Ohms at 275 Kelvin. What is the B value of this thermistor between 275 Kelvin and 300 Kelvin? (Answer to the nearest whole number)

736

44. (6.00 pts)  
Imagine a cube with each edge made of a resistor of resistance R. What would the resistance between two opposite edges of the cube be in terms of R? (Answer to three decimals)

0.833 R



Imagine the above infinite resistor ladder. If  $R = 1\text{ Ohm}$ , what is the equivalent resistance  $Z$ ? (Units not necessary, answer to 3 decimal places)

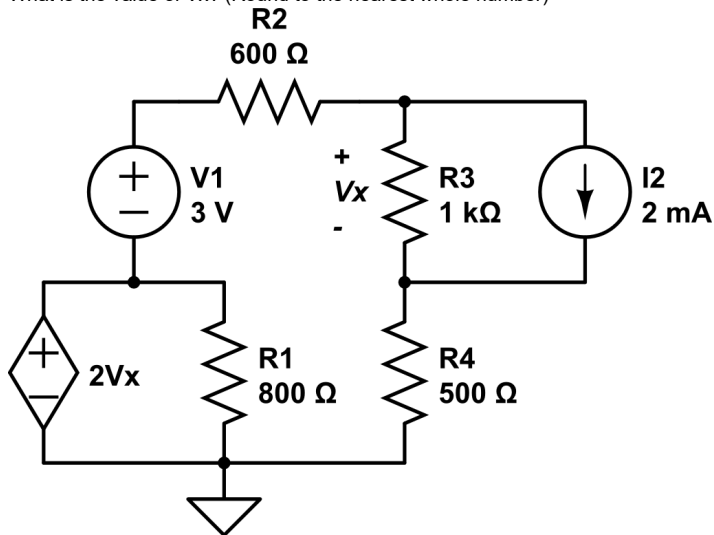
1.618

46. (9.00 pts) Describe a real-life decision synonymous with the following logic gates: AND, OR, XOR

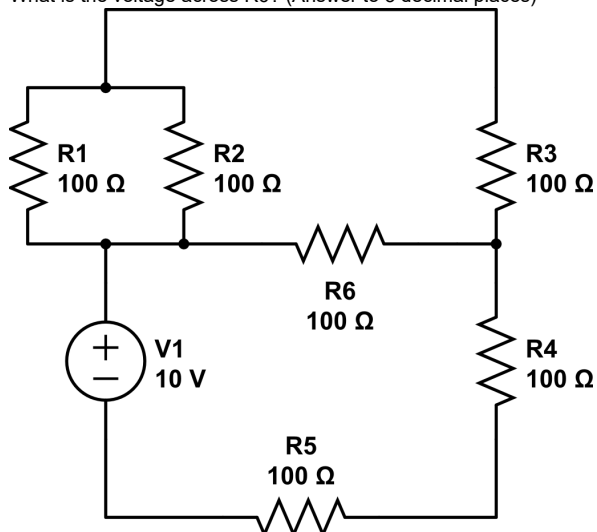
Expected Answer: Placeholder

47. (10.00 pts)

What is the value of  $V_x$ ? (Round to the nearest whole number)

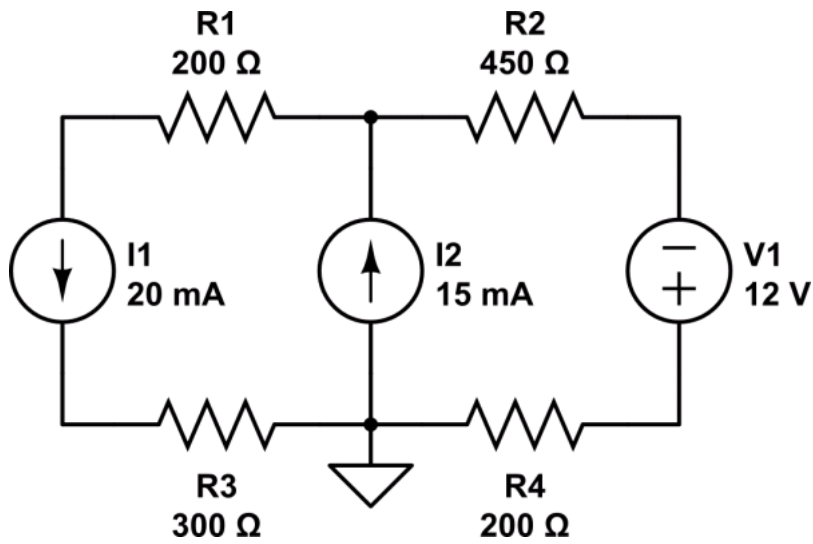



48. (6.00 pts) What is the voltage across  $R_6$ ? (Answer to 3 decimal places)

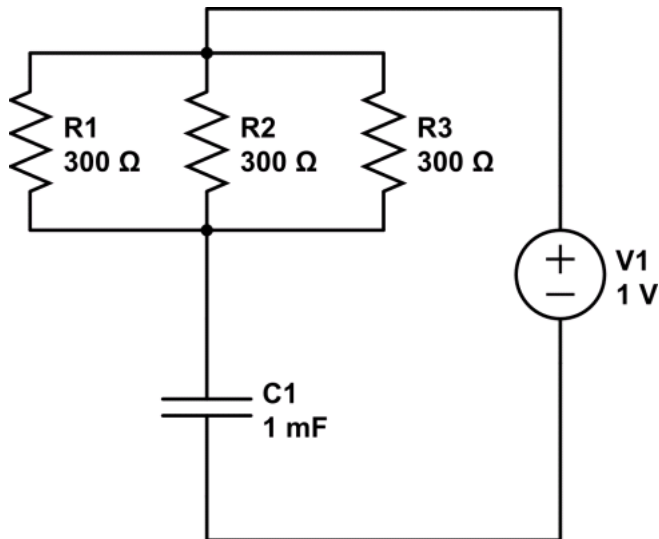



49. (8.00 pts) What is the node voltage at the point directly above the 15 mA source? (Answer to two decimals)

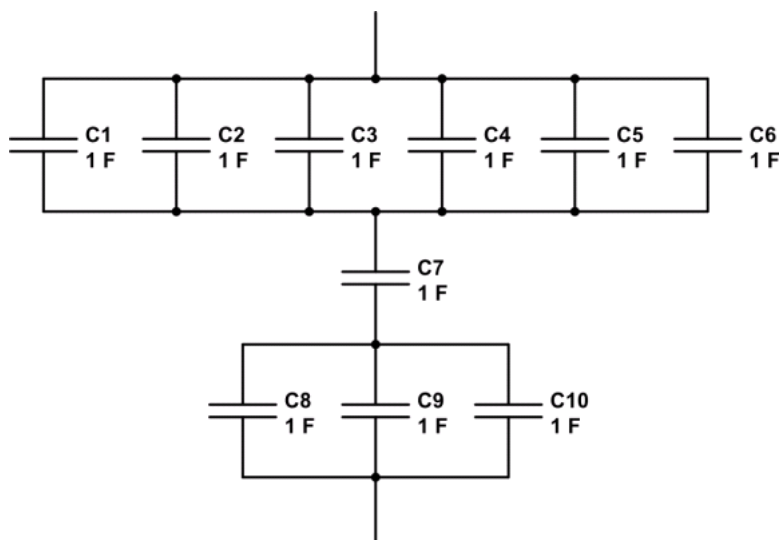




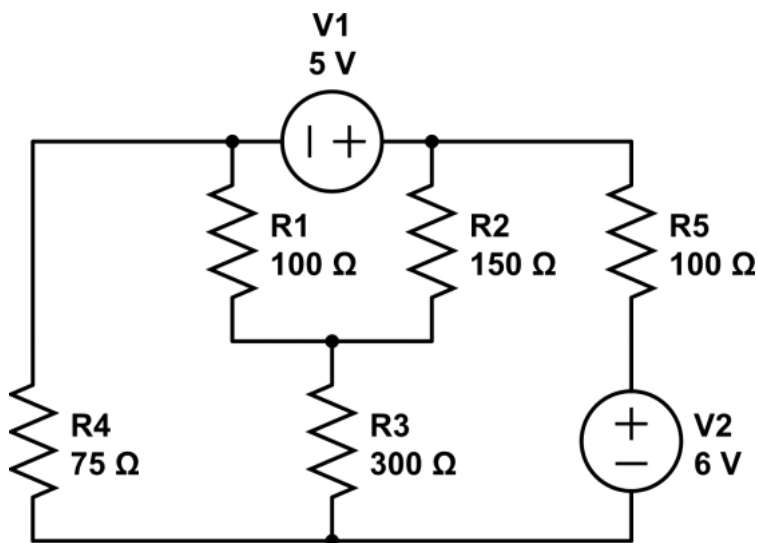

50. (5.00 pts) What is the time constant of the circuit below? (Answer to one decimal)



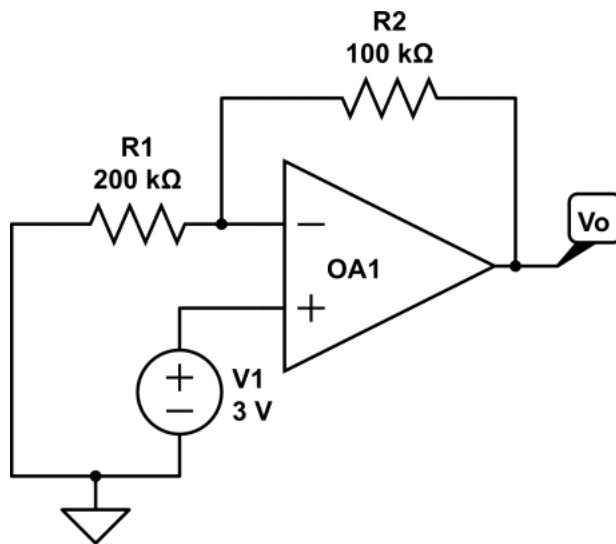

51. (5.00 pts) What is the equivalent capacitance of this network? (Answer to two decimals)



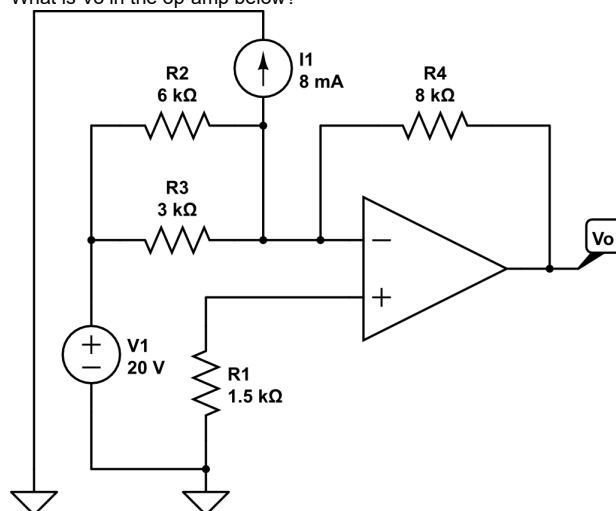

52. (8.00 pts) What is the voltage across R3? (Answer to three decimals)



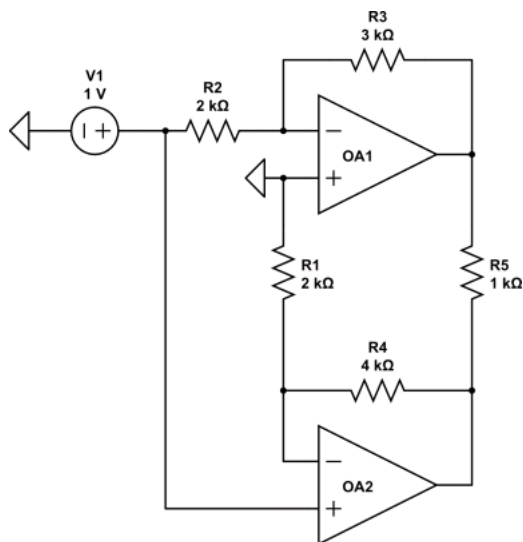

53. (6.00 pts) What is  $V_o$  of the op-amp below? (Answer to one decimal)



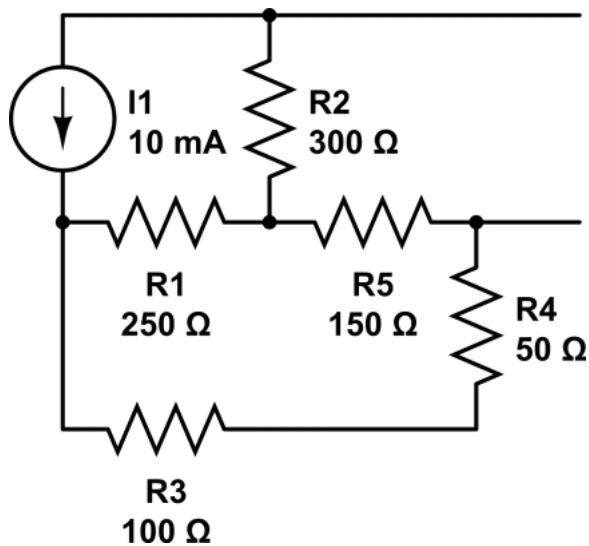

54. (10.00 pts) What is  $V_o$  in the op-amp below?




55. (8.00 pts) What is the current through  $R_5$ ? (Answer to one decimal, in mA)

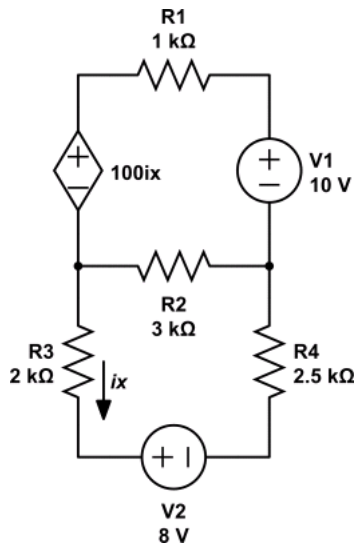



56. (12.00 pts) Find the Thevenin equivalent of the circuit below. Enter  $V_{th}$  in the first box and  $R_{th}$  in the second. (Answer to two decimals, units not necessary)



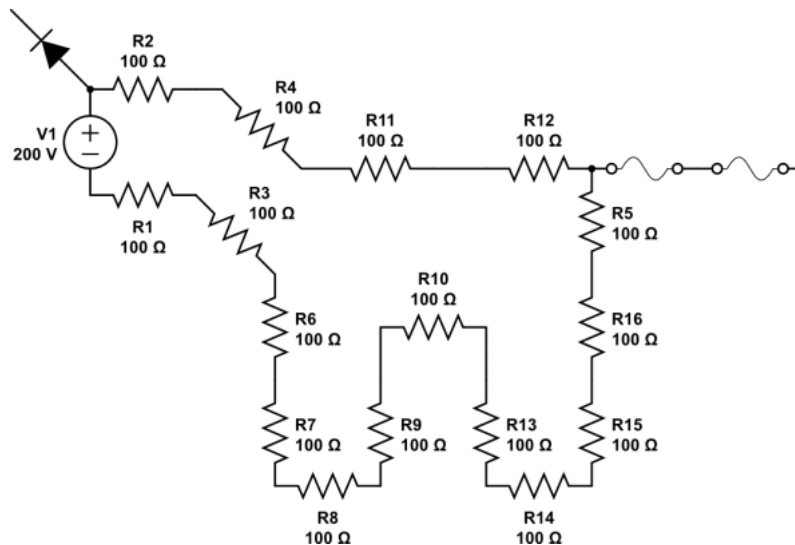


57. (8.00 pts) What is the value of  $i_x$ ? (Answer to the nearest whole number in microAmperes)




**58. (0.00 pts)** In this question, the current will be referred to as unicorn magic and the units of unicorn magic are still Amperes.

If there is no magic entering the unicorn through its tail, how much magic travels through the unicorn's eye?




Congratulations on finishing! Don't forget to check your answers. Once you do, feel free to submit. Good luck on your other events!