SSSS - 2019
Circuit Lab
DIVISION C

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Sections:

1. General Knowledge and Historical Facts
2. DC Circuits
3. Capacitors
4. Magnetism & EM Induction
5. Digital Logic
6. Misc.

School:_____

Names:_____

_____

General Knowledge and Historical Facts _____/11

1) Why can small animals such as birds and squirrels stand on power lines (with no insulation) without getting shocked? **(2)**

Use the word bank below to match the scientist with one of their contributions

Volta	Ohm	Tesla	Hertz	Faraday

2) Created a more efficient and effective method for transporting electricity in a grid

2)_____**(1)**

3) Created a law that says that the electromotive force acting between the extremities of any part of a circuit is the product of the strength of the current and the resistance of that part of the circuit

3)_____**(1)**

4) Made significant improvements to a device called the electrophorus, used for producing an electrostatic charge

4)_____**(1)**

5) Discovered that a magnetic field influenced polarized light – a phenomenon known as the magneto-optical effect

5)_____**(1)**

6) Proved that electric current has negligible mass

6)_____**(1)**

What are the Base SI units of the following quantities?
7) Electrostatic Force

7)_____**(1)**

8) Capacitance

8)_____**(1)**

9) Electric Resistance

9)_____**(1)**

10) Weber

10)_____**(1)**

11) What does LED stand for?

12)_____**(1)**

12) What is the name of the device that consist of a glass jar with layers of metal foil on the outside and inside.

13)_____**(1)**

13) Which electrical component is the device from question 13 a precursor of??

14)_____**(1)**

14) Rank the following materials based on their **resistivity** from **lowest to highest**.
   Gold, Lead, Teflon, Rubber, Tungsten

   (1)_____, (2)_____, (3)_____, (4)_____, (5)_____, **(2)**
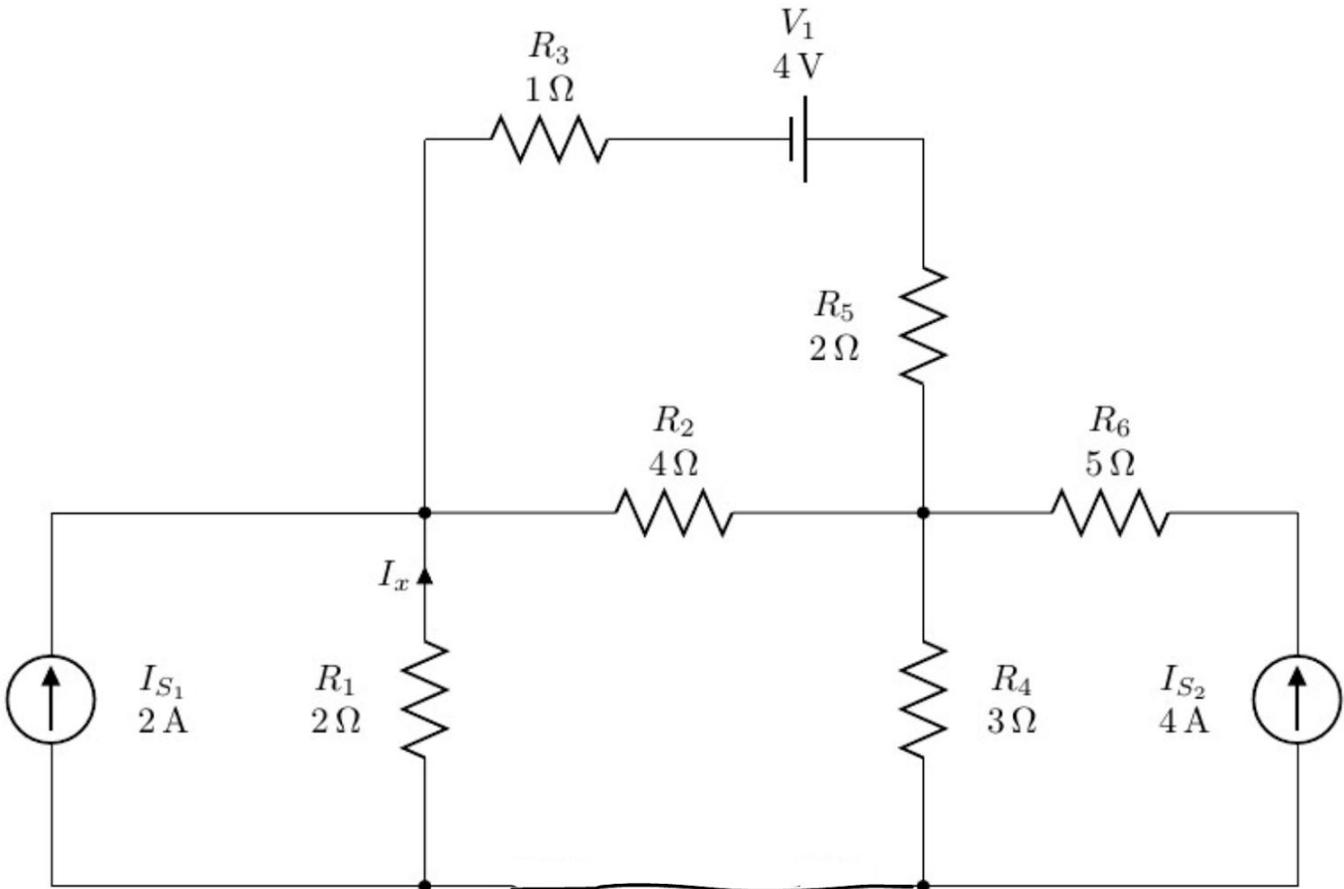
_____ 15) Who invented the first electric battery? **(1)**
a) Alessandro Volta
b) Michael Faraday
c) James Clerk Maxwell
d) Nikola Tesla

_____ 16) Who invented the first electric motor? **(1)**
a) Alessandro Volta
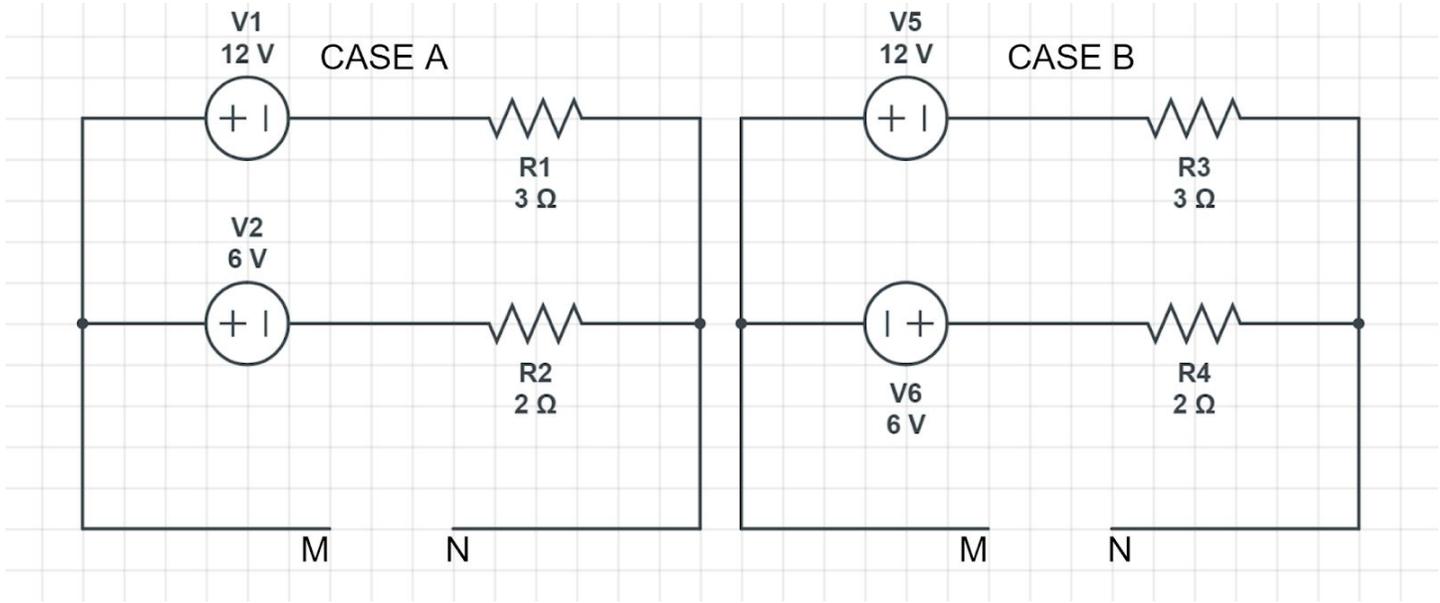b) Michael Faraday
c) James Clerk Maxwell
d) Nikola Tesla

DC Circuits

Solve the circuit   1) find the current I_x 2) find the voltage across R_2

R_3
$1\,\Omega$

V_1
4 V

R_5
$2\,\Omega$

R_2
$4\,\Omega$

R_6
$5\,\Omega$

I_x

I_{S_1}
2 A

R_1
$2\,\Omega$

R_4
$3\,\Omega$

I_{S_2}
4 A

1) $I_x=$_____**(5)** ,   2) V across $R_2=$_____**(3)**

What is the potential difference between the points M and N for the circuits below **3) for case A** and **4) case B?**

V1
12 V   CASE A

+ I

R1
3 Ω

V2
6 V

+ I

R2
2 Ω

M   N

V5
12 V   CASE B

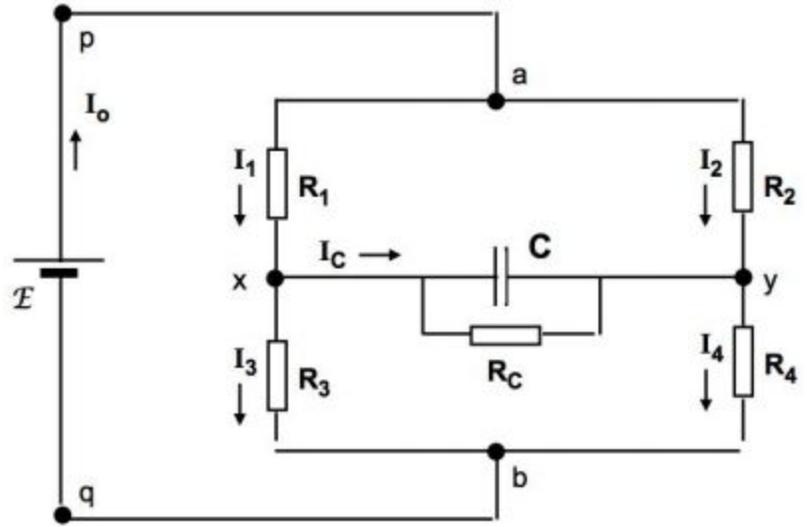+ I

R3
3 Ω

I +

V6
6 V

R4
2 Ω

M   N

3) _____(4) 4) _____(4)

5) Draw a voltage divider that will take a 15V input and yield a 6V output. **(3)**

In the circuit shown below, assume that I_1 = 3A, I_4 = 6A, R_1 = 7ohms, R_2 = 3ohms, R3 = 4ohms. The electric potential difference $V_x - V_y$ is +6V.
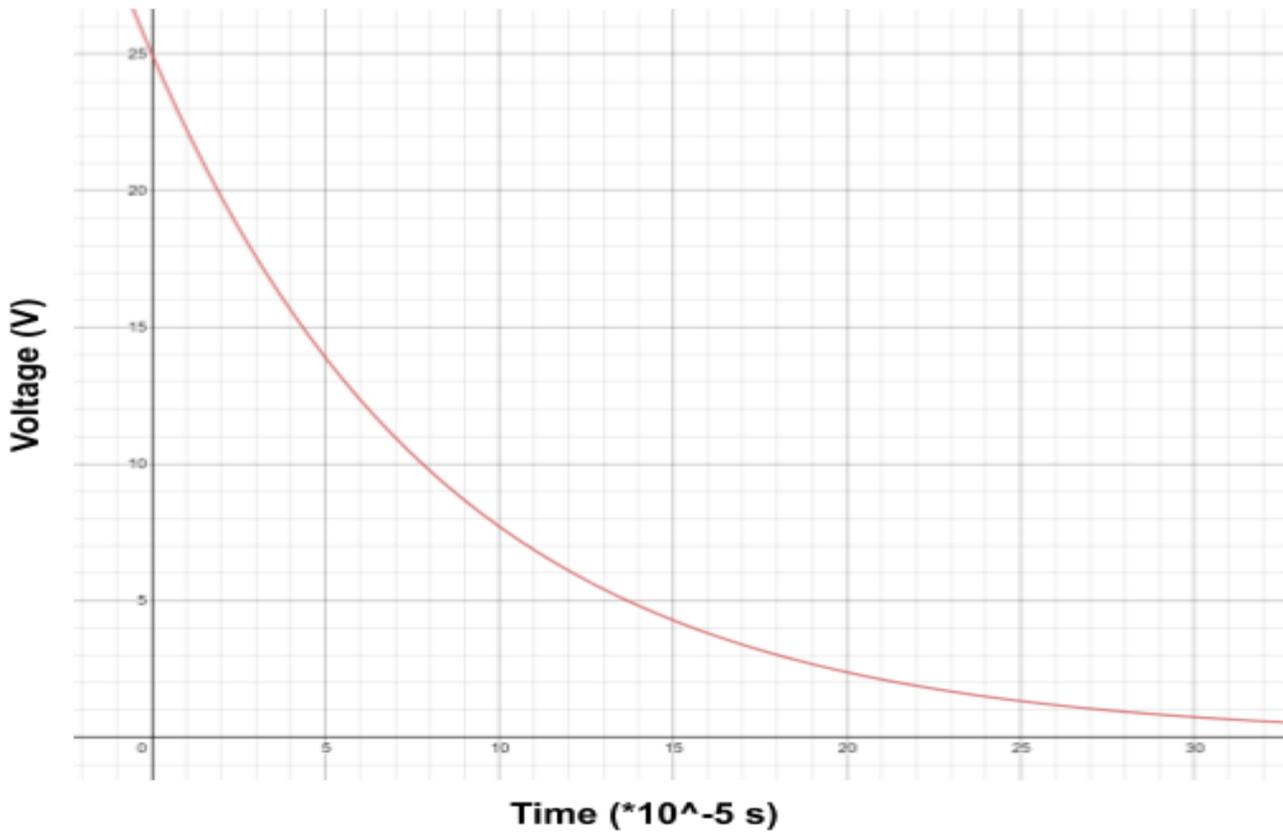
6) Find the total current I_0 =_____ **(3)**

7) Find the battery voltage E=_____**(3)**

8) How much heat in KJ is generated in resistor Rc during 1 hour? **(3)** _____

Capacitors   <u>   </u>/7

Voltage of Capacitor

Time (*10^-5 s)

Use the Voltage graph for questions 1-3

1) Approximate the time constant for this discharging capacitor.

1)<u>   </u>**(3)**

2) Draw a schematic for the circuit with a battery, **1.7 ohm** resistor, and a capacitor that represents the voltage graph above. Label the voltage of the battery, capacitance of the capacitor, and resistance of the resistor. **(3)**

3) Approximately how many time constants does it take capacitors to discharge?

3)<u>   </u>**(1)**

4) Calculate the capacitance of the unknown capacitor given that the potential difference between points A and B is zero.
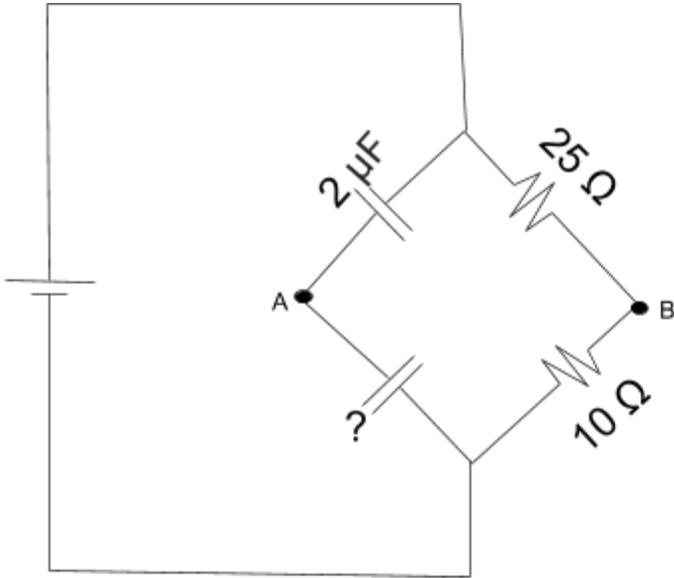

4)_____(5)

A parallel plate capacitor separated at a distance of 3.0mm and area of 5cm². A layer of polystyrene serves as a dielectric between the plates (K = 2.6). Find the **5) capacitance** with the dielectric and the **6) maximum charge** that can be stored if the dielectric breaks down at E > 20,000,000V/m.

5) _____(2) 6) _____(4)

Magnetism & EM Induction   _____/18

1) What is the EMF induced in a conductor loop of area of 30,000 cm^2 that rotates in a magnetic field of 3.62 Teslas with an angular velocity of 154 rads/s? (at the instant the loop is parallel to the field as shown below)
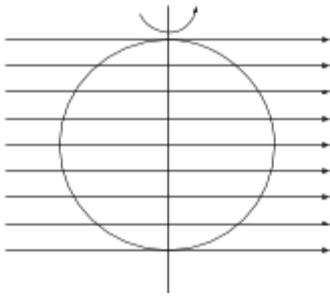
1) _____ **(6)**

_____2) Concerning the relationship between electricity and magnetism, which of the following statements is false? **(2)**
a) A constant current in a wire induces a constant magnetic field around the wire.
b) A changing current in a wire induces a changing magnetic field around the wire.
c) A constant magnetic field induces voltage in a nearby stationary wire.
d) A changing magnetic field induces voltage in a nearby wire.

_____ 3) When the current flowing through a wire reverses direction, the magnetic field around the wire **(2)**
a) Does not change
b) Increases
c) Disappears
d) Reverses direction

_____ 4) The north pole of the electromagnet is located at point **(2)**

  a) A
  b) B
  c) C
  d) D
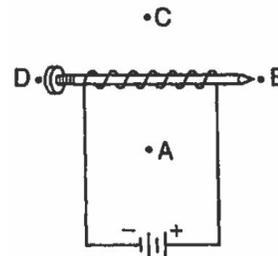
_____ 5) A proton with velocity v enters the center of a solenoid. When inside the solenoid, the proton will **(2)**
a) Slow down
b) speed up
c) remain at constant velocity
d) be attracted to the wires

_____ 6) A permanent magnet with the north pole facing down moves downwards along the page. It encounters a loop of wire and continues moving downwards through the center of the loop of wire and continues downwards. What is the initial direction of the induced current on the loop (looking at the loop from the top) **(2)**
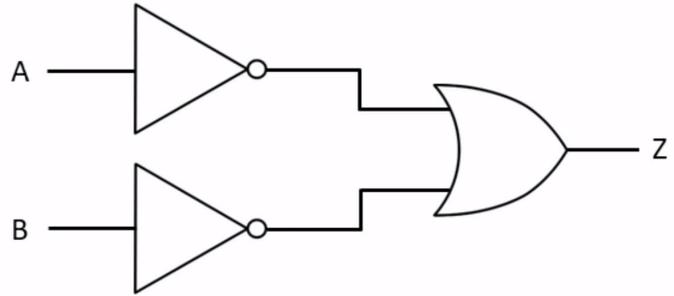a) no current is induced
b) clockwise
c) counter-clockwise
d) cannot be determined

7) If we have two long parallel wires with the current flowing in the same direction. How would the forces exerted by each wire affect the configuration of the wires over time? **(2)**

Digital Logic   _____/11

For questions 1-2 complete the truth table
1)   **(2)**

A	B			Z
0	0			
0	1			
1	0			
1	1			

2) **(3)**

A	B					Z
0	0					
0	1					
1	0					
1	1					
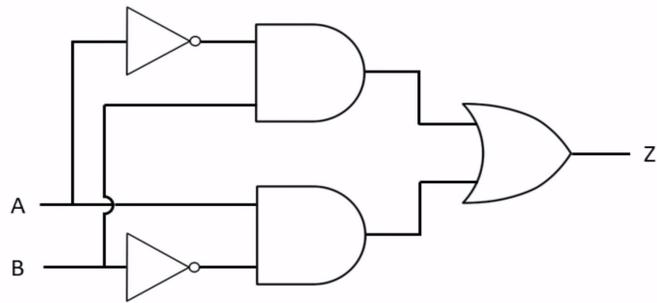
3) Which simple logic gate is the combination in **question 1** equal to? Name and draw this simplified gate. **(1)**

4) Which simple logic gate is the combination in **question 2** equal to? Name and draw this simplified gate. **(1)**

5) Expand the following function into sums of products:
F(a,b,c)=a+b^I

5) Σ=_____(4)

6) Express the following function in algebraic form and then simplify.

X	Y	Z	F(X,Y,Z)
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

6) F(X,Y,Z)=_____(6)

7) Simplify the following function:

$F=x'+xy+xz'+xy'z'$

7) F(X,Y,Z)=_____(4)

Misc.   _____/15

1) Draw the IV curves for an ideal diode and label the forward and reverse bias. **(3)**

2) Define leakage current in the context of a diode **(2)**

3) Draw a circuit where the input to a diode is AC. Then, graph the output **(2)**

4) What is one advantage of AC power transmission over DC power transmission? **(3)**

5) What is the purpose of a commutator in an electric motor? **(2)**

6) What is the voltage gain of the ideal op-amp? **(3)**