SSSS - 2019

Circuit Lab **KEY**

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.

General Knowledge and Historical Facts

1) There is no potential difference in a single wire. For electrons to move there must be a difference in electric potential
2) Tesla
3) Ohm
4) Volta
5) Faraday
6) Hertz
7) kg · m · s^-2
8) s^4 · A^2 · m^-2 · kg^-1
9) m^2 · kg · s^-3 · A^-2
10) kg · m^2 · s^−2 · A^−1
11) light emitting diode
12) leyden jar
13) capacitor
14) Lead, Gold, Tungsten, rubber, teflon
15) A
16) B

DC Circuits

1) −2.85A
2) 3.745V

I1- Bottom left loop

I2- Bottom middle loop

I3- Bottom right loop

I4- Top Middle loop

$(I2-I1)\times R1+(I2-I4)\times R2+(I2-I3)\times R4=0$

$(I2-2)\times 2+(I2-I4)\times 4+(I2+4)\times 3=0$

$2I2-4+4I2-4I4+3I2+12=0$

$9I2-4I4=-8$ **(1)**

$I4\times R3-4V+I4\times R5+(I4-I2)\times R2=0$

$I4\times 1-4+I4\times 2+(I4-I2)\times 4=0$

$7I4-4I2=4$ **(2)**

Solving equations 1 and 2, we obtain:

$I2=-4047A$, $I4=447A$

1) $Ix=I2-I1=-2.851A$

2) $IR2=I2-I4=0.9362A$

$VR2=IR2\times R2=0.9362\times 4=3.7447V$.

3) 8.4V

Use Loop rule:

+12V-6V-2I-3I=0

6V-5I=0

I=1.2A

$V_{R2,=}$=IR_2=(1.2A)(2Ω)=2.4V

ΔV=V_2+V_{R2}=6V+2.4V=8.4V

4) 1.2V

Use Loop rule:

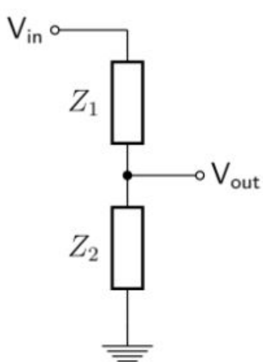
+12V+6V-2I-3I=0

18V-5I=0

I=3.6A

$V_{R4,=}$=IR_4=(3.6A)(2Ω)=7.2V

ΔV=V_{R4}-V_6=7.2V-6V=1.2V



$$V_{out} = V_{in} \cdot \frac{R_2}{R_1 + R_2}$$

5)

Z1=R1 Z2=R2; As long as the formula to the right is fulfilled. <u>Ex) R1=9V R2=6V</u>

6)10A

7) 27V

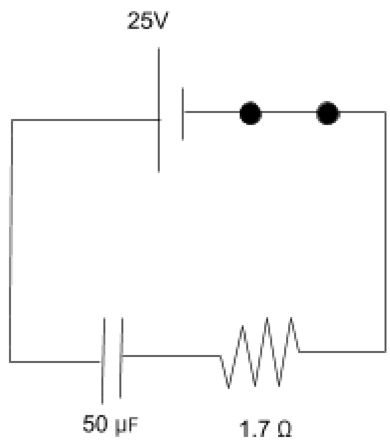
8) 21.6KJ

Capacitors

1) 85 microseconds

1 time constant has passed once V=25V/e=9.1969V

V=9.1969V at t≈8.5*10^-5s=85 microseconds



2)

τ=RC

(85*10^-6s)=(1.7 Ω)C

C=50μF

3) 5 time constants

4) 5μF

2μF/C=10μF/25μF

C=5μF

5) 3.83 pF

5cm^2=0.0005m^2

C=ε0AK/D

C=(8.85×10−12 F⋅m−1)(0.0005m^2)(2.6)/(3*10^-3m)

C=3.835pF

6)15.3μC

Magnetism and Em Induction

1) 1672 V

30,000cm^2=3m^2

EMF=ABωcos(θ)

EMF=(3m^2)(3.62T)(154rad/s)cos(0)

EMF=1672.44V

2) C

3) D

4) B

5) C

6) C

7) the two wires will attract and move closer

Digital logic

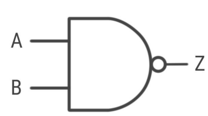
1)

A	B	A^{l}	B^{l}	Z
0	0	1	1	**1**
0	1	1	0	**1**
1	0	0	1	**1**
1	1	0	0	**0**

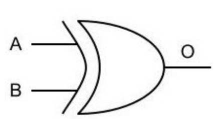
2)

A	B	A^{l}	B^{l}	$A^{l}B$	AB^{l}	Z
0	0	1	1	0	0	**0**
0	1	1	0	1	0	**1**
1	0	0	1	0	1	**1**
1	1	0	0	0	0	**0**

3) NAND



4) XOR

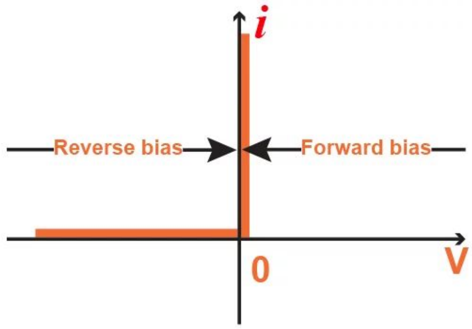


5) $\Sigma=(0,1,4,5,6,7)$

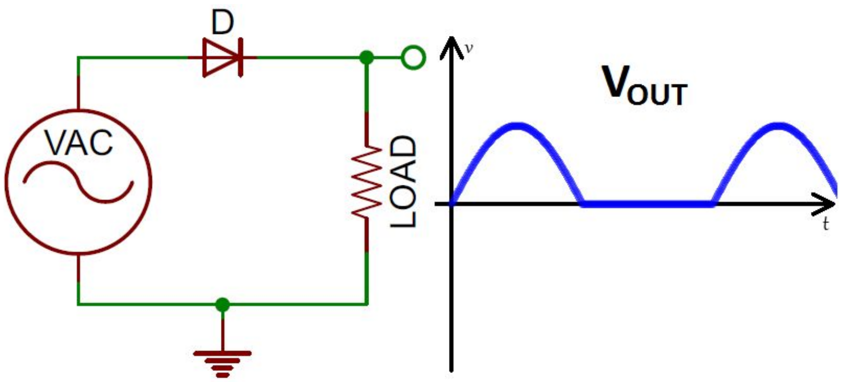
6) $F(X,Y,Z)=y^{l}+z$

7) $F(X,Y,Z)=x^{l}+y+z^{l}$

Misc

1) 

2) Current that the diode will leak when a reverse voltage (not in the direction that the diode allows) is applied to it. Occurs in realistic diodes.

3) 

4) AC transmission has a more efficient voltage step-up and step-down system using transformers but DC is more difficult. (full credit)
Easier to convert AC to DC than the other way around (only 1pt)

5) It switches the electromagnets from north and south and back again (spins the motor)

6) -3