*Objectives:

1.Analyze circuits in DC contain of resistors in series.
2. Analyze circuits in DC contain of resistors in parallel.
3.analyze series- parallel combination circuit.
4.analyze circuit by using current& voltage divider.
5.analyze delta combination.

*Theory:

1. ohm's law:

The voltage V (in volt,v) across resistor is directly proportional to the current I (in amperes, A)flowing through it.& the constant of proportionality is R(in ohm,Ω).

$$V=RI$$

2. resisters in series:

a. current through N elements in series is same for all of them.

$I_s=I_1=I_2=I_3=\ldots\ldots\ldots=I_n$

b. voltage across Ith element can determine by (Ri*Ii) ,(where i=number of element),& sum of voltage across each element equal to the voltage entire series combination.

$V_s=V_1+V_2+V_3+\ldots\ldots.+V_n=\sum V$ (this from KVL"over aclose path the sum of all elements voltages = zero")

c. the equivalent resistance of the series combination is the sum of individual resistances.
$R_{eq} =R_1+R_2+R_3+\ldots\ldots.+R_n=\sum R$
You can show this by using the previous equation & ohm law:
$V_s=V_1+V_2+V_3+\ldots\ldots+V_n$
$I_{eq}*R_{eq}=I_1*R_1+I_2*R_2+I_3*R_3+\ldots\ldots+I_n*R_n$ (where I's are equall then)
$R_{eq}=R_1+R_2+R_3+\ldots..+R_n$

3. resistors in parallel:

a. the voltage across N element same of all of them.

$Vs=V1=V2=\ldots\ldots=Vn$

b. the current through Ith element can be calculated by V/R (ohm law)

the total sum of current through each element equal to the current provided to the entire parallel combination.

$Is=I1+I2+I3+\ldots\ldots+In=\sum Ii$ (it's from KCL" the sum of the entire current in anode is equal the sum of the current which leave the same node").

C.the reciprocal of the equivalent resistance is the sum of reciprocal of individual resistances.

$1/Req=1/R1+1/R2+1/R3+\ldots\ldots+1/Rn$

You can show that by using the previous equation of current & ohm law:

$Is=I1+I2+I3+\ldots\ldots+In$

$Vs/Req= V1/R1+V2/R2+V3/R3+\ldots\ldots+Vn/Rn$ (where Vi are equals)

$1/Req=1/R1+1/R2+1/R3+\ldots\ldots+1/Rn$

4. series – parallel combination:

To analysis this type of circuit you should substituting the series or parallel combinations by either equivalent resistances , such that the circuit is transformed into a pure parallel or series circuit & then you can find the electrical parameter (current & voltage) for this equivalent resistances, also you can determine the current & voltage for the individual resistors by some method such that the relation between current & voltage which discuss previously & below.

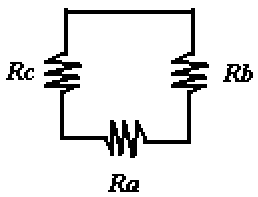
5- Voltage divider :

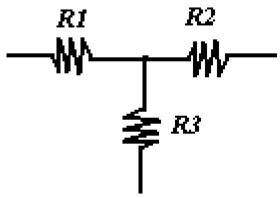
A series circuit with two resistors will divide the applied voltage Vs into two voltages V 1and V 2 across each resistor , but we should note that V 2 is the output of the voltage divider

& can calculate as this equation:
V2=R2*Vs/(R1+R2)

6- Current divider :
The parallel circuit with two resistors will divide the applied current Is into two currents I1 and I2 through each resistor , but we should note that I2 is the output of the current divider & can calculate as this equation:
I2=R1*Is/(R1+R2)

7- Delta combination circuit :
To analysis of this type of circuit you can use either mesh analysis or Δ to Y transformation formulas as you see below. This technique will simplify the circuit to a simple series-parallel combination circuit that can be solved easily.





*From Δ to Y:
R1=Rb*Rc/(Ra+RB+RC)
R2=Ra*Rb/(Ra+RB+RC)
R3=Ra*Rc/(Ra+RB+RC)
*From Y to Δ:
Ra= (R1*R2+R1*R3+R2*R3)/R1
Rb= (R1*R2+R1*R3+R2*R3)/R3
Rc= (R1*R2+R1*R3+R2*R3)/R2

*Equipment:

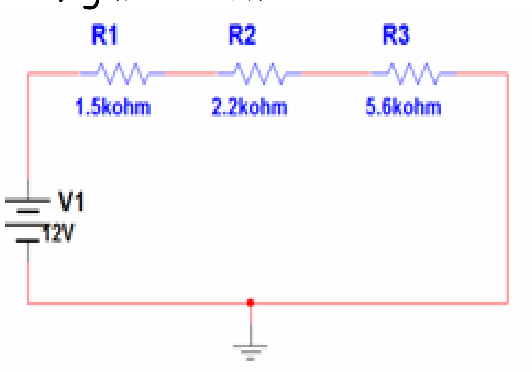
DMM,PS, wires, breadboard, 5 different resistors ,leads

*Procedure:

$.Part one: resistors in series:

1. we will take 3 different resistor (1.5, 2.2, 5.6 KΩ)

2. read their value by using color code at first.
3. fixed them in the breadboard.
4. read there values by using DMM as we learn in "experiment 1" but now read the value of each resistance in separate way of the other(first but resistance 1 in the breadboard & read their value then put the other one & so on) **note:** before we connect it to the circuit, & then record the values in the table below.
5. provide DC power supply of 12V as we learn in experiment 1.
6. connect the circuit in the breadboard as shown in the figure below:



7. be sure of the value of P.S by measured it's value by DMM as we learn in " experiment 1"& then record it's value in the table below. .
8. now we wanted to measured the value of the current "Is" which following through the circuit, by being sure that the state of the DMM as you want (putting in mA ,& the socket put in right place as in the rule we learn in"experiment 1") then take one terminal of the P.S and but it in far node & then measured the value of Is & record it's value in the table below. .
9. here we measured the value of the voltage across each resistance as we learn in "experiment 1". But for each resistance & then record the values in the table below.

	R(KΩ)	V(volt)	I(mA)
R1	1.48	1.948	1.29

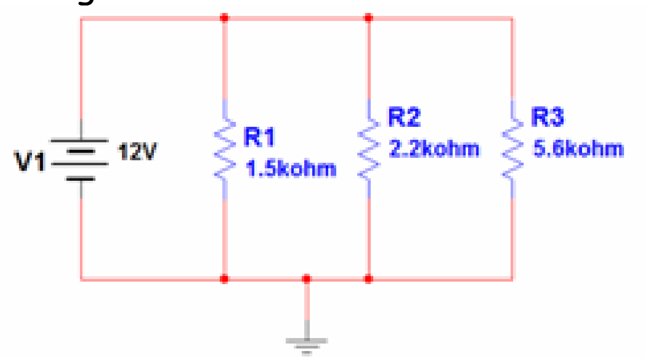
R2	2.16	2.833	1.29
R3	5.50	7.205	1.29
Vs	11.992		
Is	1.29		

Note: *that the value of Ir1=Ir2=Ir3=Is=1.29 mA (the circuit in series)

* the sum of all voltage across each resistance = 1.948+2.833+7.205=11.986 v (which mainly =Vs) (since the circuit in series)

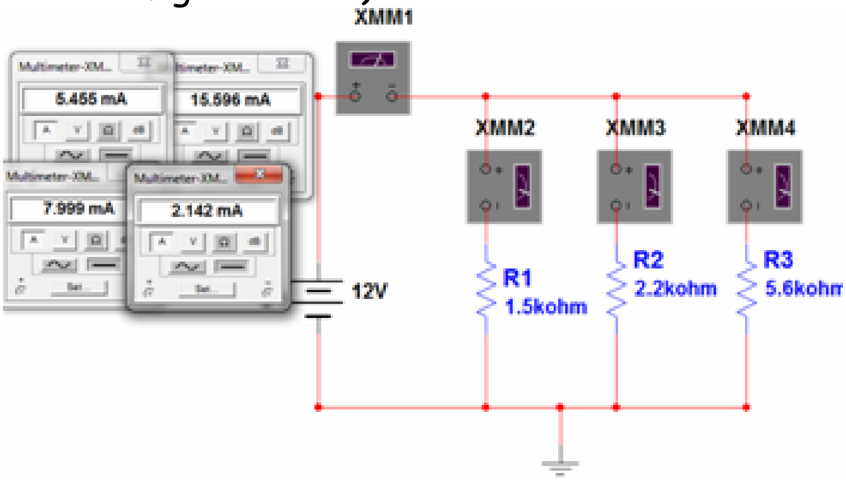
$ part two: resistors in parallel:

1. we will take 3 different resistor (1.5, 2.2, 5.6 KΩ)
2. read their value by using color code at first.
3. fixed them in the breadboard.
4. read there values by using DMM as in part one then record the values in the table below.
5. provide DC power supply of 12V as in part one.
6. connect the circuit in the breadboard as shown in the figure below:

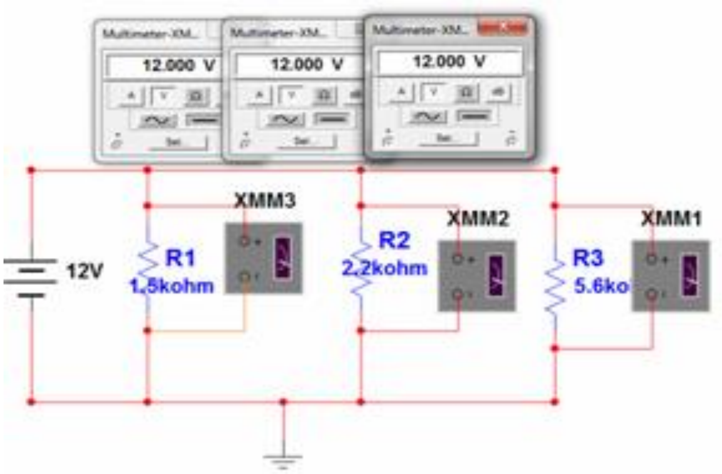


7. A. now we wanted to measured the value of the current "Is" which following through the circuit, by being sure that the state of the DMM as you want (putting in mA ,& the socket put in right place as in the rule we learn in"experiment 1") then take one terminal of the P.S and but it in far node & then measured the value of Is & record it's value in the table below

B.we wanted to measured the value of the currents "I1, I2, I3" which the current following through each resistance, by being sure that the state of the DMM as you want (putting in mA ,& the socket put in right place as in the rule we learn in"experiment 1") & then put the two probes in the two terminal of each resistance in separate way, read & record their values in the table (to connect it & measured the value see the figure below).



8. here we measured the value of the voltage across each resistance as we learn in "experiment 1". But for each resistance & then record the values in the table below(see the figure).



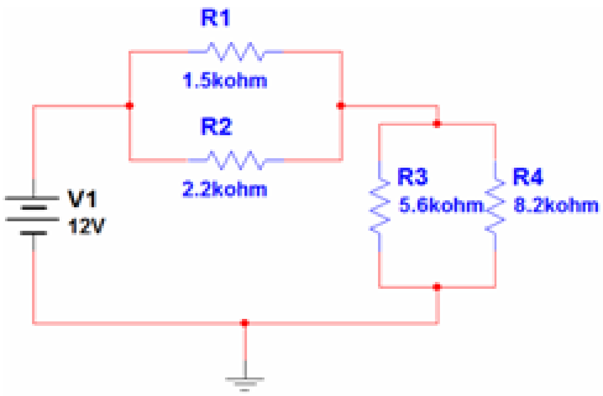
	R(KΩ)	V(volt)	I(mA)
R1	1.48	12	7.999
R2	2.16	12	5.455
R3	5.50	12	2.142
Is	15.596 mA		

Note: *that the value of Vr1=Vr2=Vr3=Vs=12 v (the circuit in parallel)

* the sum of all current following through each resistance = 7.999+5.455+2.142=15.596 mA(which =Is) (because the circuit in parallel)

$ Part three: series – parallel combonation:

1. we will take 4 different resistor (1.5, 2.2, 5.6, 8.2 KΩ).
2. read their value by using color code at first.
3. fixed them in the breadboard.
4. read the values of (1.5 ,2.2 ,5.6kΩ) by using DMM as in part one then record the values in the table below.
5. provide DC power supply of 12V as in part one.
6. connect the circuit in the breadboard as shown in the figure below:



7. disconnect the P.S & measured the value of the equivalent resistance of the circuit Ra-c.
8. here we measured the value of the voltage across each resistance(1.5,2.2,5.6 kΩ) as we learn in "experiment 1". But

for each resistance & then record the values in the table below.

9. measured the voltage Vab which represent the equivalent voltage between (1.5 ,2.2 kΩ) ,& Vbc which represent the equivalent voltage between (5.6 ,8.2 kΩ)

10.be sure of the value of P.S by measured it's value by DMM as we learn in " experiment 1"& then record it's value in the table below.

11. now you want to measured Is,Ir1,Ir2,Ir3 as (we done in the previous part & learn in experiment 1)

	R(kΩ)	V(volt)	I(mA)
R1	1.48	2.54	1.693
R2	2.16	2.54	1.176
R3	5.50	9.447	1.718
Ra-c	4.155 kΩ		
Vab	2.54 v		
Vbc	9.447 v		
Vs	11.992 v		
Is	2.81 mA		

Note:*Vr1=Vr2=Vab (R1&R2 in parallel & Vab is the equivalent of it).

- Vab+Vbc=Vs= 11.992

* Ir1+Ir2=Is=2.81 mA(R1& R2 are parallel

$Part four: voltage & current divider:

1.we will take 3 different resistor (1.5, 2.2, 5.6 KΩ)

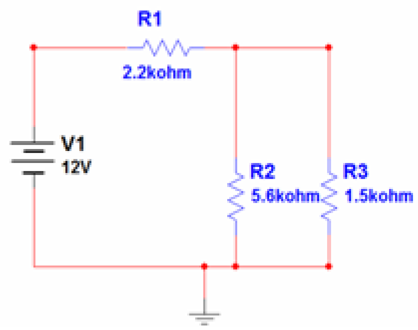
2.read their value by using color code at first.

3.fixed them in the breadboard.

4.read there values by using DMM as we learn in "experiment 1" but now read the value of each resistance in separate way of the other(first but resistance 1 in the breadboard & read their value then put the other one & so on) **note:** before we connect it to the circuit, & then record the values in the table below.

5.provide DC power supply of 12V as we learn in experiment 1

6.connect the circuit in the breadboard as shown in the figure below:



7. here we measured the value of the voltage across each resistance(1.5,2.2,5.6 kΩ) as we learn in "experiment 1". But for each resistance & then record the values in the table below.

8. now you want to measured Is,Ir1,Ir2,Ir3 as (we done in the previous part & learn in experiment 1)

9. finally measured the value of the voltage across the equivalent resistance(5.6,1.5 kΩ).

	R(kΩ)	V(volt)	I(mA)
R1	2.16	7.77	3.597
R2	5.5	4.21	0.765
R3	1.48	4.21	2.845
Vs	11.992 v		
Vo	4.21 v		
Is	3.48 mA		

Note:* Vo=Vr2=Vr3=4.21 v

*Ir2=Is*R3/(R3+R2)

Vo=Vs(R2//R3)/(R1+R2//R3)

$ part five:delta combination:

1.we will take 5 different resistor (1.5, 1.5,2.2, 8.2,6.8 KΩ)

2.read their value by using color code at first.

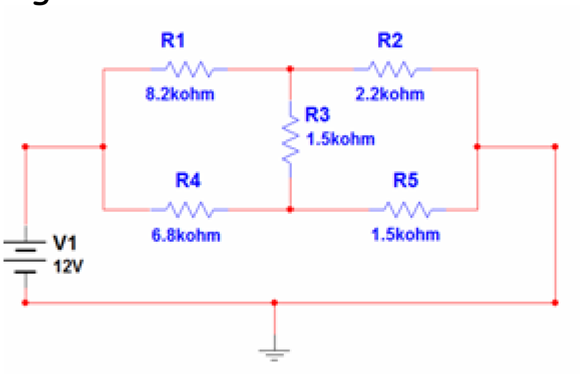
3.fixed them in the breadboard.

4.read there values by using DMM as we learn in "experiment 1" but now read the value of each resistance in separate way of the other(first but resistance 1 in the breadboard & read their value then put the other one & so on) **note:** before we connect it to the circuit, & then record the values in the table below.

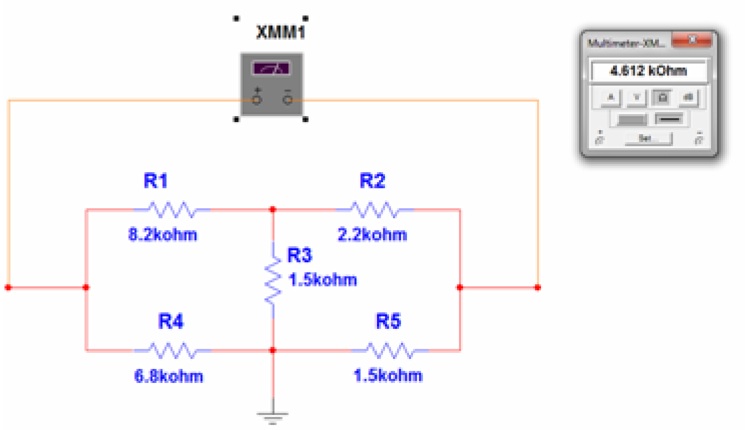
5.provide DC power supply of 12V as we learn in experiment "1"

6. be sure of the value of P.S by measured it's value by DMM as we learn in " experiment 1"& then record it's value in the table below.

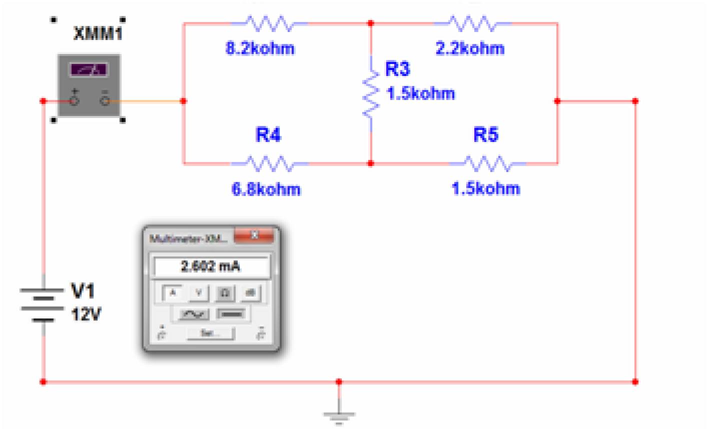
7.connect the circuit in the breadboard as shown in the figure below:



9. disconnect the P.S & measured the value of the equivalent resistance of the circuit Rx-y.



10.finally we want to measured Is as show before.



	R1	R2	R3	R4	R5	Rx-y	Vs	Is
Value	8.1kΩ	2.16kΩ	1.48kΩ	6.77kΩ	1.48kΩ	4.614kΩ	11.992v	2.602mA

***Conclusion:**

1. In the parallel circuit all resistance in parallel (there is two common terminal between them" at the same nodes") have the same voltage , but the current for each resistance can determine by using ohm law & the value of Req will be more small than the smallest resistance.
2. In the series circuit all resistance in series(which has one common terminal only "one node") have the same current & in this experiment equal Is , but the voltage each resistance can determine by using ohm law.
3. you can simplify any circuit to pure parallel or series circuit by using some method such as : Req (in parallel or series method) , current & voltage divider & converted from Y toΔ & from Δ to Y method.
4. from this experiment I will verification of the theoretical analysis by measurement value.
5. all of the above laws based on ohm & kirchhoff laws.
6. the current divider using in parallel circuit where the voltage divider using in series circuit.
7. the theoretical value mayby greater than or less than or equal of the measured value.
8. if there is Rn of resistance which has the same value , you can determine the value of the Req in parallel ,Req=r/ n.

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Experiment "2" (Measurement On DC Circuit)

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*Date: 22/june/2010

*Day: Tuesday