# TWO PHYSICAL CONCEPTS, OHM AND GAUSS

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**Abstract—** Electricity is a fundamental concept applied in industry and factory business. It has some principles raised from physics science. Electricity has some different branches used in living and industry such as magnetism and electronics. Electricity physics includes laws and regulations through the science. We investigate two applied laws, Ohm and Gauss in the paper. These concepts and research presented are got from an annual project.

**Keywords—** Physics, Electricity, ohm, gauss.

## I. OHM'S LAW

Say that you're wiring a circuit. You know the amount of current that the component can withstand without blowing up and how much voltage the power source applies. So you have to come up with an amount of resistance that keeps the current below the blowing-up level.

In the early 1800s, George Ohm published an equation called Ohm's Law that allows you to make this calculation. Ohm's Law states that the voltage equals current multiplied by resistance, or in standard mathematical notation:

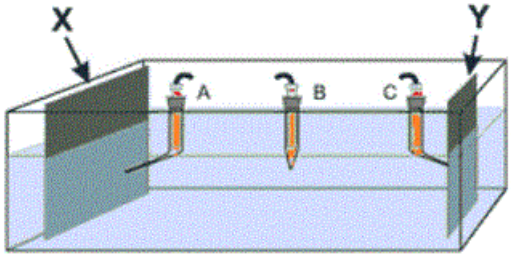
V = I x R

The statement of Ohm's law is simple, and it says that whenever a potential difference or voltage is applied across a resistor of a closed circuit, current starts flowing through it. This current is directly proportional to the voltage applied if temperature and all other factors remain constant. Thus we can mathematically express it as:$V \propto I$Now putting the constant of proportionality we get, V=I This particular equation essentially presents the statement of this law where I is the current through the resistor, measured in Ampere (Ampere, or amps), when the electric potential difference V is applied across the resistor in unit of volt, and ohm(Ω) is the unit of measure for the resistance of the resistor R. It's important to note that the resistance R is the property of the conductor and theoretically has no dependence on the voltage applied, or on the flow of current. The value of R changes only if the conditions (like temperature, diameter length etc.) of the material are changed by any means.

## II. HISTORY OF OHM'S LAW

In the month of May 1827, Georg Simon Ohm published a book by the name 'Die galvanischeKette, mathematischbearbeitet' meaning "The galvanic circuit investigated mathematically" where he presented the relationship between voltage(V), current(I), and resistance(Ω) based on his experimental data. He performed his experiment with a simple electro-chemical cell, as shown in the figure below.

1. There were two copper electrodes X and Y.
2. Reference electrodes A, B and C are partly immersed in electrolyte as shown.
3. A glass container is used to hold the for electrolyte, as shown.




By observing the results of this experiment, Georg Simon Ohm had defined the fundamental interrelationship between current, voltage and resistance of a circuit which was later named Ohm's law . Because of this law and his excellence in the field of science and academics, he got the Copley Medal award in 1841. In 1872 the unit of electrical resistance was named 'OHM" in his honor.

## III. GAUSS'S LAW

In physics, Gauss's law, also known as Gauss's flux theorem, is a law relating the distribution of electric charge to the resultingelectric field. The law was formulated by Carl Friedrich Gauss in 1835, but was not published until 1867. It is one of Maxwell's four equations, which form the basis of classical electrodynamics, the other three being Gauss's law for magnetism, Faraday's law of induction, and Ampère's law with Maxwell's correction. Gauss's law can be used to derive Coulomb's law, and vice versa.

It expresses that: The net electric flux through any closed surface is equal to 1⁄ε times the net electric charge enclosed within that closed surface.

Gauss's law has a close mathematical similarity with a number of laws in other areas of physics, such as Gauss's law for magnetism and Gauss's law for gravity. In fact, any "inverse-square law" can be formulated in a way similar to Gauss's law: For example, Gauss's law itself is essentially equivalent to the inverse-square Coulomb's law, and Gauss's law

for gravity is essentially equivalent to the inverse-square Newton's law of gravity.

Gauss's law is something of an electrical analogue of Ampère's law, which deals with magnetism.

The law can be expressed mathematically using vector calculus in integral form and differential form, both are equivalent since they are related by the divergence theorem, also called Gauss's theorem. Each of these forms in turn can also be expressed two ways: In terms of a relation between the electric field E and the total electric charge, or in terms of the electric displacement field D and the free electric charge.

- Although Gauss' Law is a fundamental law of electrostatics, it mis only of limited use for finding fields produced by sources
- This is because in integral form it describes an integration of fields; after a function is integrated, a lot of information is lost!
- Example: Suppose the electric field flux out of a surface is zero - is the field on that surface then necessarily zero?
- It is only possible to use the integral form of Gauss' Law for finding fields produced by particular sources if the sources have a very high degree of symmetry
- We can also try to find a "differential form" of Gauss' Law: one that applies at a point instead of over some integrated region of space
- To do this, simply shrink the surface S to be infinitesimally small - leads to the definition of "divergence"
- We can use the integral form of Gauss' law to find the fields produced by a specific set of charges if the charges possess a high degree of symmetry
- Based on the symmetry, we can find "Gaussian surfaces" over which the field has only a normal component, and on which that component is constant
- If this is true, the total flux is just the field component times the surface area; setting this equal to the charge enclosed determines the amplitude of the field component
- Types of sources for which this will work: – infinite line charge (cylindrical coords) infinite cylinder surface/volume charges (cylindrical coords) – spherical surface/volume charges (spherical coords) – surface charges on an infinite plane (Cartesian coords)
- In all these cases, the line, volume, or surface charge densities have to be constant

## CONCLUSIONS

One of the fundamental laws describing how electrical circuits behave is Ohm's law. According to Ohm's law, there is a linear relationship between the voltage drop across a circuit element and the current flowing through it. Therefore the resistance R is viewed as a constant independent of the voltage and the current.

As these electrons flow through the wire, they are scattered by atoms in the wire. The resistance of the circuit is just that; it is a measure of how difficult it is for the electrons to flow in the presence of such scattering. This resistance is a property of the circuit itself, and just about any material has a resistance. Materials that have a low resistance are called conductors and materials that have a very high resistance are called insulators. Some materials have a moderate resistance and still allow some current to flow. These are the materials that we use to make resisters like the ones we will use in this experiment. In short, the electric potential causes the current to flow and the resistance impedes that flow.

## REFERENCES


[1] Serway, Raymond A. (1996). Physics for Scientists and Engineers with Modern Physics, 4th edition. p. 687.

[2] Grant, W.R. Phillips (2008). Electromagnetism (2nd ed.). Manchester Physics, John Wiley & Sons. ISBN 978-0-471-92712-9.

[3] Grant, W.R. Phillips (2008). Electromagnetism (2nd ed.). Manchester Physics, John Wiley & Sons. ISBN 978-0-471-92712-9.

[4] Matthews, Paul (1998). Vector Calculus. Springer. ISBN 3-540-76180-2.

[5] George E. Owen (2003). op. cit.. Mineola, N.Y.: Dover Publications. p. 285. ISBN 0-486-42830-3.

[6] Billingham, A. C. King (2006). Wave Motion. Cambridge University Press. p. 179. ISBN 0-521-63450-4.

[7] Slater and N.H. Frank (1969). Electromagnetism (Reprint of 1947 ed.). Courier Dover Publications. p. 83. ISBN 0-486-62263-0.

[8] Daniel M. Siegel (2003). Innovation in Maxwell's Electromagnetic Theory: Molecular Vortices, Displacement Current, and Light. Cambridge University Press. pp. 96–98. ISBN 0-521-53329-5.

[9] James C. Maxwell (1861). "On Physical Lines of Force" (PDF). Philosophical Magazine and Journal of Science.

[10]Plonsey R. and R.C. Barr. 2007. Bioelectricity: A Quantitative Approach. 3rd edition, Springer, New York.

[11]Nicholson, C. and J.A. Freeman. 1975. Theory of current source-density analysis and determination of conductivity tensor for

[12]anuran cerebellum J. Neurophysiol. 38: 356-368.

[13]B´edard, C., H. Kr¨oger and A. Destexhe. 2004. Modeling extracellular field potentials and the frequency-filtering properties of extracellular space. Biophys. J. 64: 1829-1842.

[14]B´edard, C. and A. Destexhe. 2009. Macroscopic models of local field potentials and the apparent 1/f noise in brain activity. Biophys. J. 96: 2589-4608.

[15]Jackson, J.D. 1962. Classical Electrodynamics. John Wiley & Sons, New York.

[16]Nicholson C. and E. Sykov˜a. 1998. Extracellular space structure revealed by diffusion analysis Trends Neurosci. 21: 207-215.

[17]B´edard, C., H. Kr¨oger and A. Destexhe. 2006. Model of low-pass filtering of local field potentials in brain tissue. Phys. Rev. E 73: 051911.

[18]Bosetti C.A., M.J. Birdno and W.M. Grill. 2008. Analysis of the quasi-static approximation for calculating potentials generated by neural stimulation, J Neural Eng ., 5: 2589-4608.


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