International Journal of Academic Engineering Research (IJAER)
ISSN: 2643-9085
Vol. 4, Issue 6, June – 2020, Pages: 23-29

Simulations and Modellings of Electromagnetic Effects under Direct Current Source.

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Abstract: *Electromagnetism has been a fundamental concept in electronics with virtually all electrical appliances for man's economical, domestical and industrial outputs.Hence, the core principles of electromagnetic inductions are requisites in the optimizations of its applications. A simulated models with PhET was adopted in this study by interacting the generated magnetic force (T) against the effects of the DC volage (1,2,3,4,5,6,7,8,9,& 10 volts) through the specified number of loop/coil(1 ,2,3,& 4). The plots with respect to loop number: 1 (R^2=1.0000), 2 (R^2=1.0000), 3(R^2=0.9920) & 4(R^2=0.9964) ;simulating a direct current of :1 (0.247A), 2 (0.185A), 3(0.189A) & 4(0.88A); the averaging length of the loop : 1 & 2 (159.09m),3 (2.74m) & 4(5.30m) and average cross sectional area of 1 & 2(79512.73m^2), 3(23.59m^2) & 4(88.25m^2) with a constant permittivity of 1.257 × 10-6 H/m and standard conditions according to Micheal faraday theory on electromagnetism.*

Keywords: Electromagnetism, PhET simulations, DC voltage, magnetic field and loop/coil.

1.0 INTRODUCTION

Michael Faraday first discovered electromagnetic induction way back in the 1830s. Faraday realized that, an induced current will be generated with an Electromotive Force or Voltage, when he moved a stable magnet to and fro a loop of wire. And therefore what Michael Faraday found was a method to generate electric current within a circuit by just using the intensity of the magnetic forces but never batteries. It therefore significantly contributed to a very important principle that links electricity and magnetism (Faraday's theory of electromagnetism) [1]. If the magnet is forced towards the coil, the Galvanometer's pointer deflects to a particular direction away from its central position. The galvanometer pointer drops back to zero once no practical measure through the magnetic field [1]. Similarly, as the magnetic field is coordinated in the other position away from the coil, the galvanometer's pointer deflects in the opposite position with respect to the initial direction showing a polarity change. Drifting of the magnet to and fro through the coil moves the galvanometer's pointer according to the magnet's directional motion. Additionally, having the magnet at a stationary position, the coil movement also alters the galvanometer directions. The effect of rotating a wire loop across the magnetic field triggers a voltage that is proportional to its speed within the coil. Then it can be affirmed that the stronger the magnetic field movement the greater the induced emf or voltage in the coil, so for Faraday's law to be valid there must be "relative movement" Or the motion in between the magnetic force and the spindle. Therefore, it can be deduced that there is an interaction between the electrical voltage and the magnetic strength in relation to the renowned theory of Michael Faraday's electromagnetic induction "that a voltage is produced in a circuit whenever relative motion occurs between a conductor and a magnetic field and that the magnitude of this voltage is proportional to the rate of change of the flux" [1]. Basically, electromagnetic induction is the process of applying magnetic fields to generate current with voltage in a closed circuit [1]. Hence by this effect, the magnitude of voltage that can be generated is ascertained by raising the size of wire loops as the induced EMF is the function of all the entire loops within the coil. Therefore, if there are 50 turns within the coil there must be 50 times more induced emf than the loop of wire, affecting the relative velocity with the magnet and coil. If the same number of coil moves with the same degree of the magnetic force, as the velocity is raised, the wire automatically cut the links of flux with a rapid pace this will produce more induced emf and increase magnetic field power. When the same coil of wire is passed through a higher magnetic force at the same speed, more emf will be generated as there are more lines of force to be broken. The typical generator of the dynamo type with a stable magnet that rotates across a rotating shaft with a number of wire mounted beside the rotating magnetic field. The magnetic flux around the top and bottom of the coil varies continuously between a north and a south pole .The rotational motion of the magnetic field resulted in the induction of an alternating emf within the coil as described by Faraday's electromagnetic induction law. The intensity of the electromagnetism is directly proportional to the density of the flux, β the number of loops giving the conductor total length, l in meters and the rate or velocity at which the magnetic field varies in meters / second or m / s inside the conductor, giving the moving emf expression[2].Consequently, electromagnetism (EM) is the basis with the fundamental principles with many electrical engineering branches, and indirectly touches other categories [3]. For instance, several laws in electrical circuits theories can be inferred from EM laws. The higher computing clock rates allow electrical impulses to be more electromagnetic in computer chips and circuits that also implies mastering the manipulation of these requires a basic understanding of EM [4]. EM involves wireless communication systems, radar technology and antenna studies. In addition, microwave engineering supports those technologies, which is a significant branch of EM [4]. Mathematical modeling has historically supported understanding of EM phenomena, where solutions to simpler models are pursued for understanding complex concepts. The mathematical modeling branch in EM has now been replaced with computational electromagnetics, where solutions to complex models can be efficiently sought. EM laws can also be applied to the fields of subsurface sensing, optics, power systems, remote sensing, EM sources at all frequencies, terahertz systems, many other electrical engineering branches and terahertz systems. The knowledge in electrical fields is essential to understand process parameters principles of several nanotechnology and semiconductor products. Most electrical signals can be transmitted as electromagnetic radiation, and thus, communications, power, and signal processing are indirectly affected by our interpretation of the laws of EM.PhET integrated simulation models are initiatives of Boulder University of Colorado. It is a nonprofit fully accessible educational tool that generates explorable explanations with basics. These were invented by Carl Wieman, the Nobel laureate, in 2002. With Wieman's vision, PhET started to improve the way science is learnt [5].Originally, the project acronym "PhET" was for "Physics Education Technology" but PhET eventually spread to several other scientific fields. The project is now designing, developing, and publishing over 125 better evaluation simulations in the fields of physics, chemistry, biology, earth science, and mathematics for educational use. The simulation models were transcribed more than 65 languages, including Spanish; Arabic, Chinese and German; and the PhET website registered more than 25 million users in 2011. PhET simulation modeling was announced as the laureate of the Microsoft Education Software Award in October 2011. PhET integrated models combine research-based, effective teaching practices to boost the learning culture in science and mathematics. The modellings are expandable, so that they can be engaged as demonstrations of lectures and laboratories activities. A game like, intuitive setting in which learners can understand within a simplified scientific environment, where dynamic visual representations make the invisible relevant, and also where scientific basics are directly associated with the realities in the society [5].

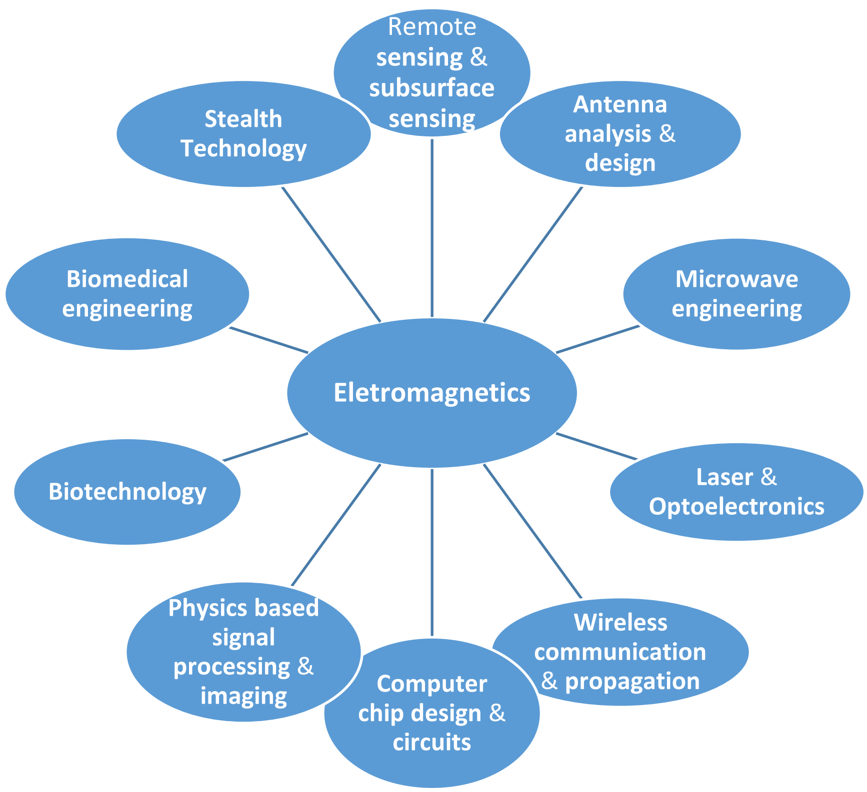

Figure 1. Applications of electromagnetics

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2.0 RESULTS AND DISCUSSIONS

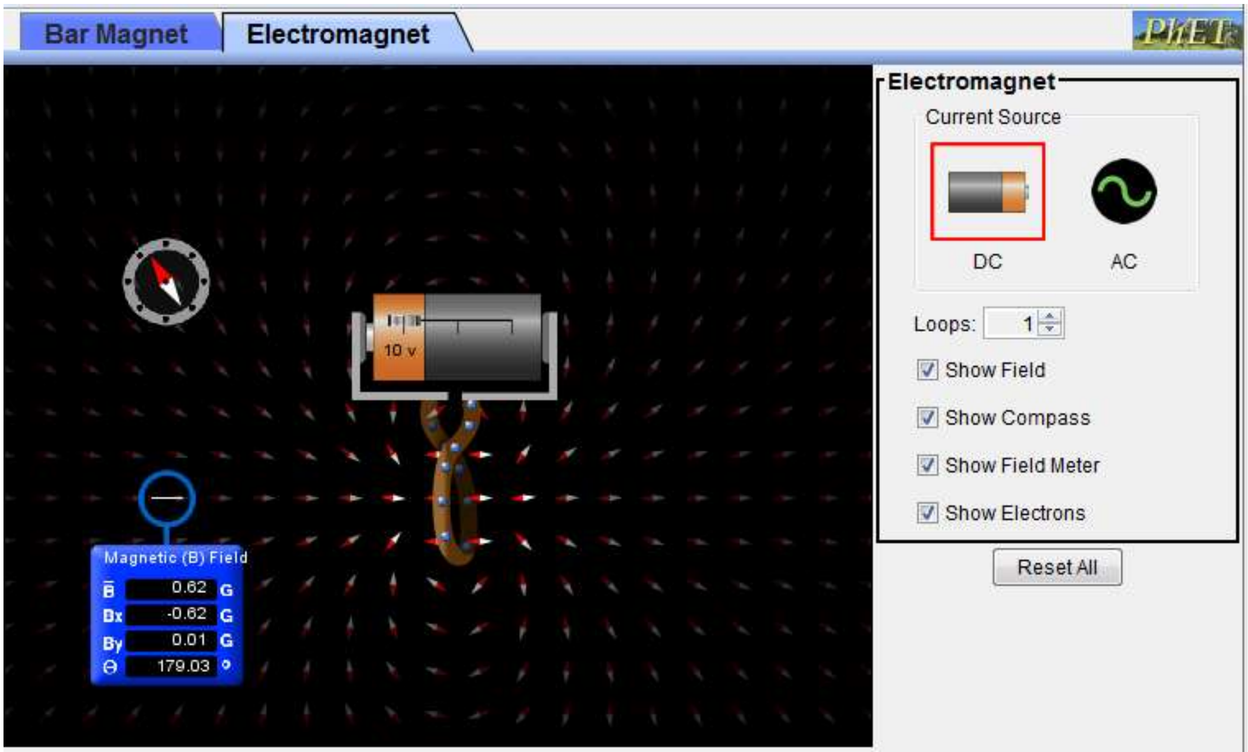

Figure 2. Electromagnetic induction with single loop under DC voltage

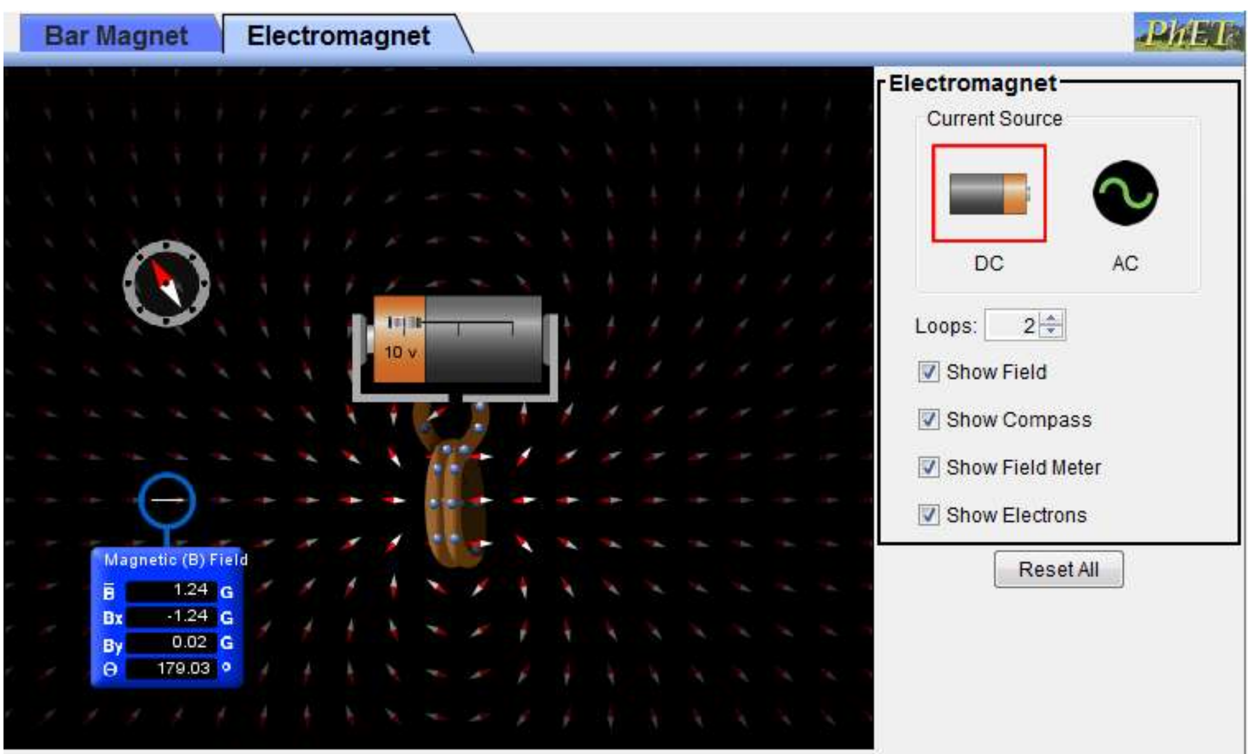

Figure 3. Electromagnetic induction with double loops under DC voltage

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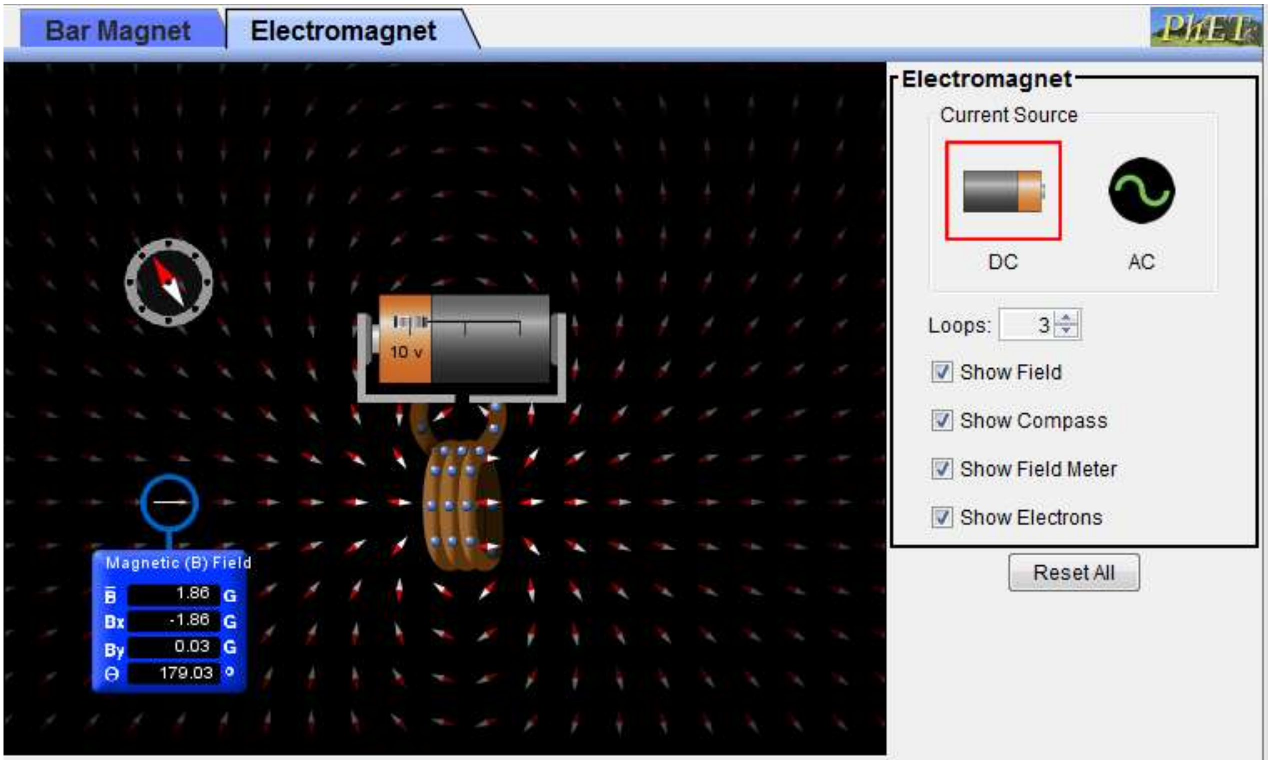

Figure 4. Electromagnetic induction with triple loops under DC voltage

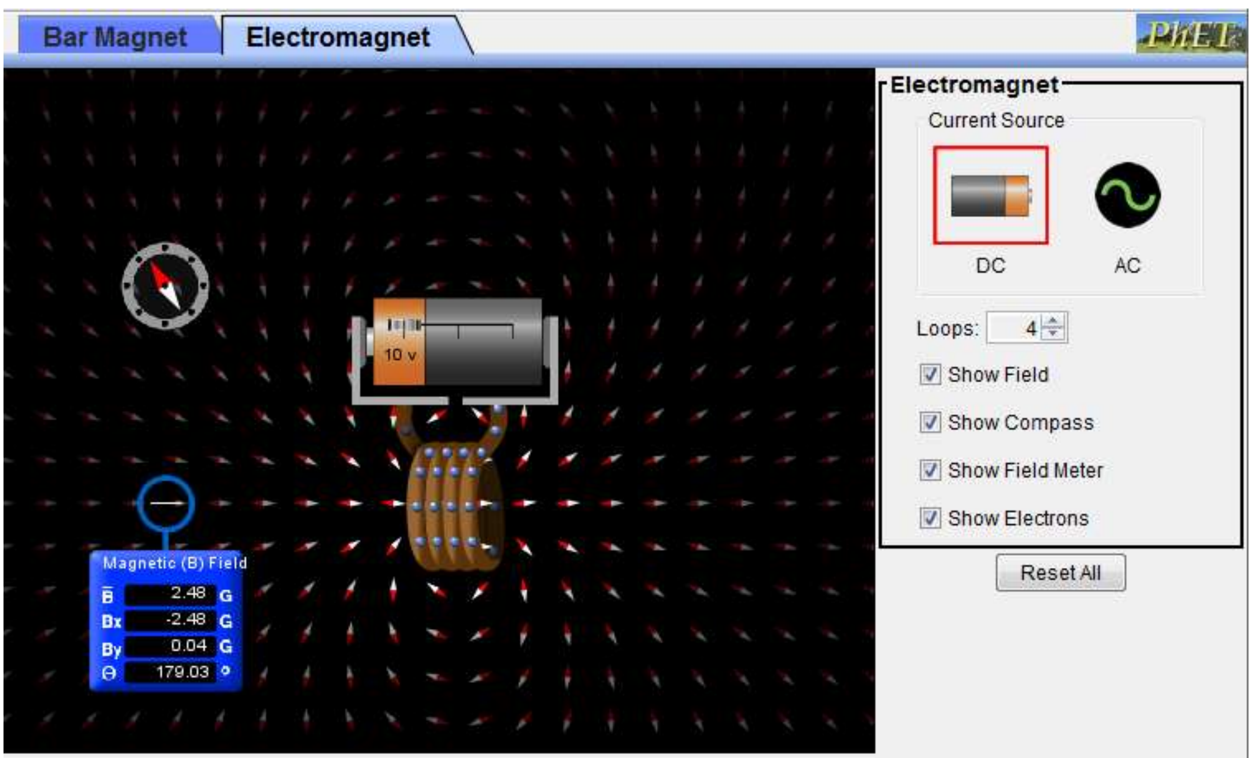

Figure 5. Electromagnetic induction with four loops under DC voltage

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Table 1. Relationship between the loop number, DC voltage and the magnetic field strength of the loop/solenoid.

Solenoid/loop	Voltage(v)	B (T)
	1	0.08
	2	0.15
	3	0.23
	4	0.30
	5	0.38
	6	0.51
	7	0.60
1	8	0.68
	1	0.17
	2	0.34
	3	0.51
	4	0.68
	5	0.85
	6	1.03
	7	1.20
	8	1.51
	9	1.70
2	10	1.89
	1	0.19
	2	0.37
	3	0.56
	4	0.74
	5	0.93
	6	1.12
	7	1.30
	8	1.49
	9	1.67
3	10	1.86
	1	0.25
	2	0.50
	3	0.74
	4	0.99
	5	1.24
	6	1.49
	7	1.74
	8	1.98
	9	2.23
4	10	2.48

Table 2. Extrapolations from the plot of magnetic field against DC voltage.

Solenoid [coil number]	Current (I)(ampere)	r (m)	Area(m^2)	R^2
1	0.247	159.09	79,512.73	1.000
2	0.185	159.09	79,512.73	1.000
3	0.189	2.74	23.59	0.992
4	0.088	5.30	88.25	0.996

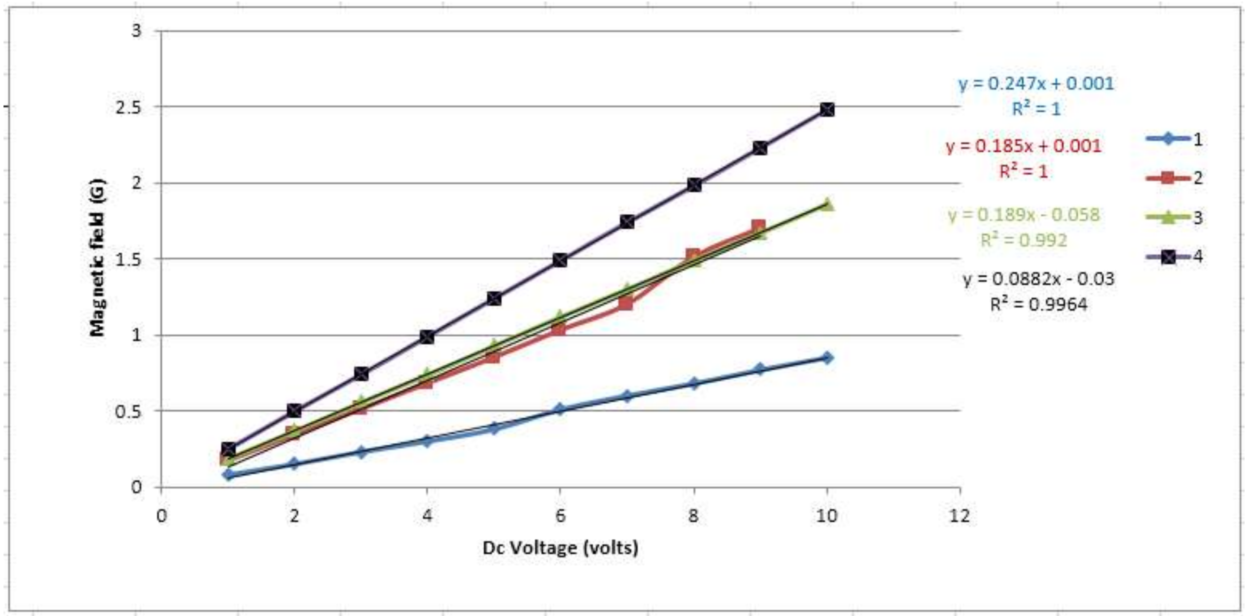

Figure 5. Plots of the magnetic field against the DC voltage with respect to the number of loops (coil/solenoid)

Figure 2, 3, 4, and 5 were the display of the electromagnetic modellings with PhET simulation at a single, double, triple and quadruple number of loops under direct current source with the imaginary magnetic material. The induced magnetic field over the range of 1 to 10 Dc volts were correlated as plots (Figure 5).

3.0 CONCLUSION

Theoretically, the loop's nature as a coil around the magnetic field generates a static magnetic field around itself which forms the shape of a bar magnet giving a distinct North and South pole. The induced magnetic flux or force around the loop is directly proportional to the current through the loop. In other words, the more the wire turns, the greater the force around the magnetic field. So what if we modified this principle by disengaging the electrical signal away from the coil and inserting a bar magnet within the core of the coil of wire instead of a hollow core. With the movement of this bar magnet "to" and "fro" within the coil, the physical motion around the magnetic force will still create a current in the coil. Similarly, if we held the bar magnet fixed and shifted the coil forth and back inside the magnetic field, the coil would also produce an electrical current. Then a voltage and current can be induce inside the coil by either shifting the wire or increasing the magnetic field (Electromagnetic Induction) and this is the fundamental operating concept of motors, transformers and generators.

4.0 AKNOWLEDGEMENT

The authors appreciated the ingenuity of Carl Wieman of University of Colorado Boulder USA.

5.0 REFERENCE

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