Quest Journals
Journal of Research in Humanities and Social Science
Volume 8 ~ Issue 12 (2020)pp: 14-17
ISSN(Online):2321-9467
www.questjournals.org

Computing Electric Field along the Centre of Rod Which Is Bent In the Form of Arc

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ABSTRACT
The estimation of an integral is integration. Math integrals are used to classify several useful numbers, such as regions, numbers, displacement etc. When we talk about integrals, they are commonly connected to definite integrals. For anti-derivatives, infinite integrals are used. Integration is one of the two key calculus topics in mathematics, apart from differentiation which measures the rate of change of any function with regard to its variables, and electricity can be produced by motion by Brownian movement of electrons through the conductor. We found that a tiny electric current flows through the conductor when charge is incorporated into the rod like copper wire. Here we discuss how integration helps in calculus and Computing Electric Field along the centre of Rod which is Bent in the form of arc.
KEYWORDS: *Differentiation, Integration, Vector, Scalar, Electric Field, Brownian movement Charge and Limits.*

R*eceived 05 December, 2020;* ***A****ccepted 20 December, 2020 © The author(s) 2020.*
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I. INTRODUCTION

In the 17th century, the main advance in integration came with Leibniz and Newton's separate discovery of the fundamental theorem of calculus. Before Newton, Leibniz published his thesis on calculus. It made it possible for precise analysis of functions inside continuous domains, given the name infinitesimal calculus.

Faraday sought the solution in 1831. Electricity could be produced by motion by magnetism. He noticed that a tiny electrical current passes through the wire as a magnet is passed inside a coil of copper wire. H.C, H.C. Oersted proved, in 1820, that electric currents create a magnetic field.

Preliminaries:

1.1 ELECTRIC FIELD:

The electric field per unit charge is known as the electric power. The field's position is taken to be the direction of the force on a positive test charge that it will exert. From a positive charge, the electrical field is radically outward and radically towards a negative point charge.

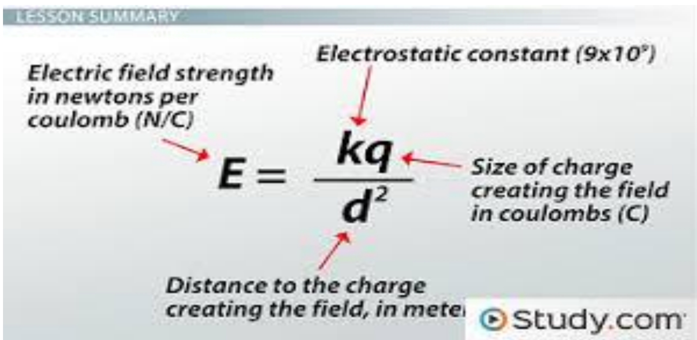


Figure-I

Here the charge which is present inside the rod or conductor which we have taken is STATIC charge. Moving charges are not considered because moving charges produce electricity which leads to formation of an open circuit causing causalities in the calculation of the electric field. But static charge helps us to identify the electric field around the rod in the form of imaginary lines.

1.2 COLUMBS INVERSE SQUARE LAW:

Coulomb's law or *Coulomb's* inverse-square law is experimental law of physics that quantifies the amount of force between two stationary, electrically charged particles. In the case of a single stationary point charge, the two laws are equivalent, expressing the same physical law.

1.3 COMPUTATION OF ELECTRIC FIELD USING INTEGRATION

Let us consider a Rod which is bent in the form of an arc of circular ring which is containing a charge Q throughout it. Let the Bent rod Arc makes of a circular R (μ) and consider the length of Rod is "L". As the Rod is uniformly charge throughout it, Consider" λ" be a constant ratio and r is the radius of arc

$$\lambda = \frac{\text{Total charge}}{\text{Total length}} = \frac{Q}{L}$$

Now consider a very small part of the Bent arc which contains a charge (very small) "dQ" and Length "dL"

$$\text{Implies} \quad \lambda = \frac{dQ}{dL}$$

We get dQ= λ dL --- (1)

Let the small part makes angle ø with the y aixis and ends of parts makes "dø " with it

We know that Length L= rø

dL= r dø ----(2)

Substituting equation (1) in equation (2)

We get dQ = λr dø

We know that Electric Field can be defined as $\vec{E} = \frac{K\Phi}{r^2}$

Where E is distance between point and charge

$$\text{Here} \quad d\vec{E} = \frac{Kd\Phi}{r^2} = \frac{K\lambda dL}{r^2} = \frac{K\lambda\, d\phi}{r^2} = \frac{K\lambda d\phi}{r}$$

Here $d\vec{E}$ can be divided into two components that components are $d\vec{E}$cosø along y- axis and $d\vec{E}$sinø along x- axis

But $d\vec{E}$sinø is cancelled throughout the arc due to its mirror element at same angle on the other side of x- axis except at 90^{0}, and then we can calculate only on y-axis. This can be observed by the figure -II

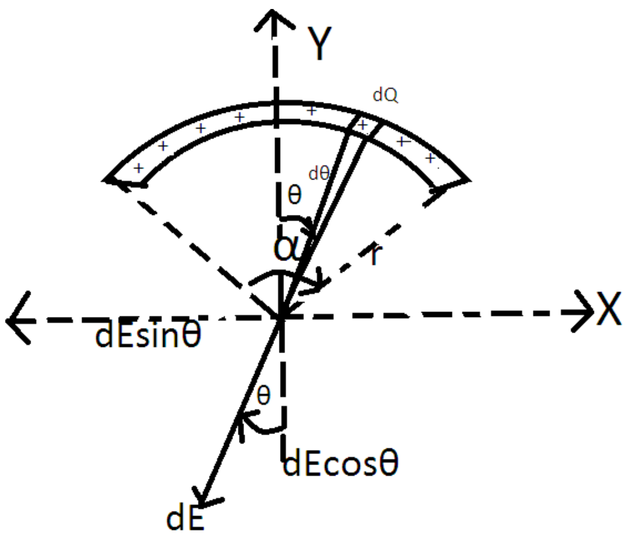


Figure-II

So, here we can use integration which helps us to find total Electric Field. It is used to join each and every part of the Rod by taking the limits

$-\frac{\alpha}{2}$ And $+\frac{\alpha}{2}$

$$\overrightarrow{E_{net}} = \int_{\frac{-\alpha}{2}}^{\frac{\alpha}{2}} d\vec{E}\cos\phi \; d\phi = \int_{\frac{-\alpha}{2}}^{\frac{\alpha}{2}} \frac{K\lambda d\phi}{r}\cos\phi$$

After integration and substituting limits

We get Total Electric Field $\overrightarrow{E_{net}} = \frac{2K\lambda}{r}\sin\left(\frac{\alpha}{2}\right)$

So, For a Bent rod arc angled α has an Electric Field $\frac{\boldsymbol{K\lambda d\phi}}{\boldsymbol{r}}$ **sin**$\left(\frac{\boldsymbol{\alpha}}{\boldsymbol{2}}\right)$ to ward centre where $k = \frac{1}{4\Pi\epsilon_0} = 9X10^9$ (constants)

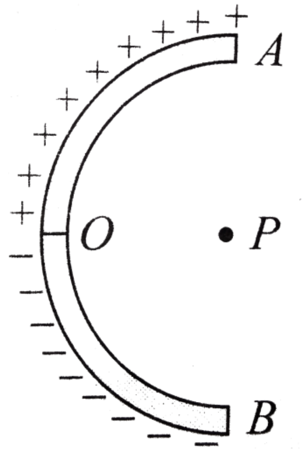
Here λ = Linear Charge density, α= Angle of Arc

1.4 OBSERVATION OF THE RESULTANT ELECTRIC FIELD WITH DIFFERENT ANGLES:

1.41: For a Semi Circle, $\alpha = \Pi^c = 180^0$

So we get Electric field at the angle 180^0 (Figure-III)

$$\overrightarrow{E_{net}} = \frac{2k\lambda}{r}$$



(Figure-III)

1.42: For Quadrant, $\alpha = \frac{\Pi}{2} = 90^0$

So, we get Electric Field at the angle 90^0 (Figure-IV)

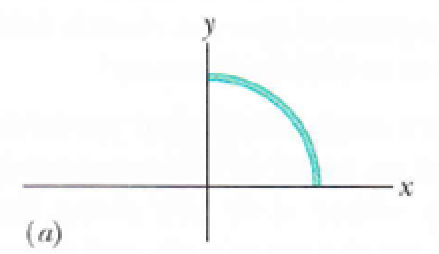
Along x-axis

$$\overrightarrow{E_{net}} = \frac{k\lambda}{r}$$

Along y-axis

$$\overrightarrow{E_{net}} = \frac{k\lambda}{r}$$

Finally we get $\overrightarrow{E_{net}}$ (Quadrant) $= \frac{\sqrt{2}}{r}k\lambda$



(Figure-IV)

II. CONCLUSIONS:

From these observations and calculations we can conclude that integration plays a crucial role in identifying the accurate value of the computing electric fields along the centre of Rod which is bent in form of arc and we had computed Electric Field of rod which is bent in the form of semicircle and Quadrant from the obtained result.

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