Electromagnetism
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Lecture – 74
Fringing magnetic field

Hello, we have introduced the magnetic field found out the expression for magnetic field under different conditions. And we have also derived amperes law in the context of magnetostatics. Now, let us consider a situation, where we can see fringing fields in the case of magnetostatics.

In the case of electrostatics, we considered finite parallel plate capacitor and at the edge of that capacitor we found fringing electric field, where it was not perpendicular to the plates of it. It had a direction along the parallel component to the along the parallel, to the plates as well.

Now, similar situation with magnetostatics can come, if we consider a solenoid, but of finite size. At the end of the solenoid we will find magnetic field that is not completely along the z direction, but it has also some R component some radial component of it how should it look like?

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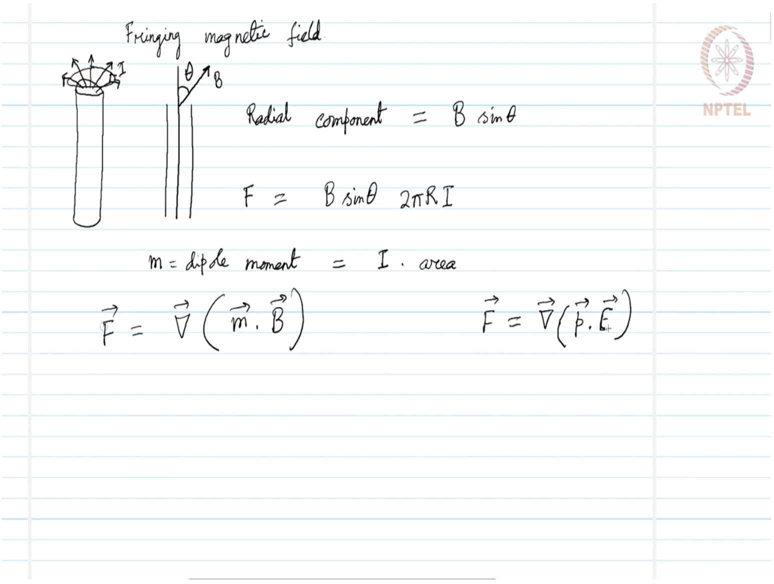

So, if we consider a finite solenoid like this, this is an end this is another end. So, here at this end the magnetic field would point along these directions; something like this and these are the fringing magnetic fields.

Now, if we consider such a solenoid and if this be the axis of the cylinder and at a given point here, the magnetic field points along this direction. So, if this angle is called theta then the radial component of this magnetic field can be given as B times sin theta. B times cosine of theta will give us the component along the z direction and sin theta will give us along the other direction that is radial direction.

Now, if we consider a loop like this, that carries a current I along this direction what will happen on for this loop, due to this fringing field. So, here we have a magnetic field with R component the with some radial component in it. So, the force magnetic force will come from v cross B. So, if we consider v in this direction and B in radial direction v in phi direction and B in radial direction then the force direction would be sorry v of the charge along phi direction.

And the magnetic field along z direction, then the force will be along radial direction. And if we consider the charge along phi direction and charge movement along phi direction and the magnetic field along radial direction.

Then we will have we can see that for this kind of an arrangement the force would be downward in the cylinder. So, this ring will come to the solenoid and that component can be written as B sin theta. This times if capital R is the radius of the solenoid then it will be twice pi R times I; radius of this ring that we have.

Which means for an infinitesimal loop with dipole moment m; m is area times where m is the dipole moment, that is given by current times the area. With this, we can write down the force in that case will be given as the gradient of m dot B. Its very similar to the force in case of electric fringing fields that was the gradient of p dot electric field.