Electromagnetism
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Lecture – 71
Magnetic dipole

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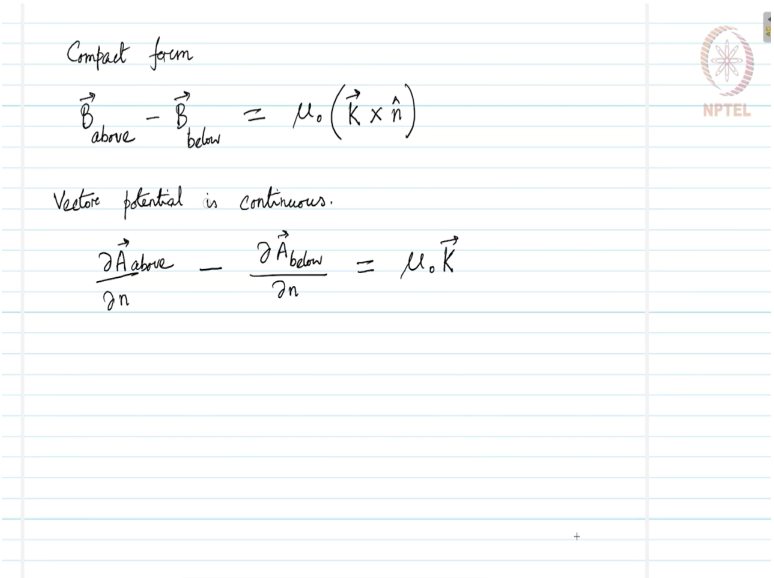

After analyzing the vector potential in these details let us consider the idea of a Magnetic dipole.

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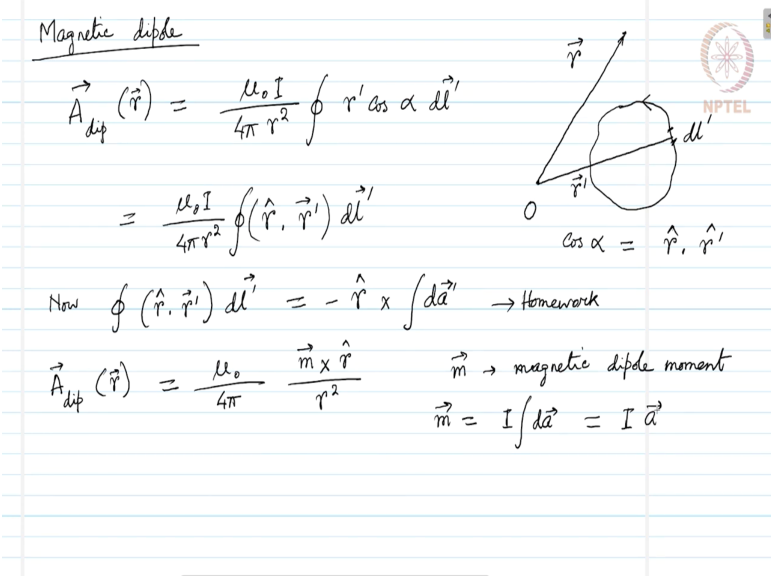

So, what would be the potential due to a magnetic dipole? We can write it in terms of the vector potential. The vector potential due to a magnetic dipole can be given as mu naught I over 4 pi r squared closed line integral over r prime cosine of alpha dl prime. So, what is cosine of alpha alpha? What kind of picture are we considering here? If we have a current carrying loop of any arbitrary shape and here we have a line element on this that is d l prime. So, and we are trying to find out the vector potential due to this dipole that is this current.

So, a current that encloses an area makes a dipole. So, here if we have some arbitrary coordinate system origin here then this vector would be represented as r and this vector would be r prime. Now, this cosine of alpha is given by r cap dot r prime cap, this is the angle that we are talking about this is the cosine of alpha. And this is what we are integrating over the line element on the current carrying loop that is dl prime. So, this expression can be written as mu naught I over 4 pi r squared closed integral over r cap dot r prime vector d l prime.

Now, we can write closed integral over r cap dot r prime vector dl prime this quantity dl prime we always considered with a vector sign ok. So, this quantity can be expressed as minus r cap cross integration over da prime.

So, this how this comes? Is a homework for you and once we have this then we can write the magnetic dipole or vector potential as a function of the position vector r given as mu naught over 4 pi m vector cross r cap vector over r squared where m vector is the magnetic dipole moment. And this is given as I the current times integration of da; that means, current times the area of the loop a is the vector area enclosed by the current loop.