Institutt for fysikk, NTNU
TFY4155/FY1003: Elektrisitet og magnetisme
Spring 2005

Summary, week 15 (April 12 and 13)

Magnetic force on electric current

[FGT 28.4; YF 27.6; TM 26.1; AF 24.9; LHL 23.2; DJG 5.1.3]

Straight conductor, length L, current I:

$$\boldsymbol{F} = I\boldsymbol{L} \times \boldsymbol{B}$$

In general: Conducting wire with length L, current I, arbitrary shape on conductor:

$$\boldsymbol{F} = \int_L d\boldsymbol{F} = I \int_L d\boldsymbol{l} \times \boldsymbol{B}$$

Magnetic force between parallel current-carrying wires

[FGT 29.1; YF 28.4; TM 27.2; AF 24.14; LHL 23.5]

Force pr unit length between parallel wires with current I_1 and I_2, respectively:

$$f = \frac{\mu_0 I_1 I_2}{2\pi r}$$

where r is the distance between the wires.
Same direction for the currents $\Rightarrow$ attraction
Opposite direction for the currents $\Rightarrow$ repulsion

Ampere's law

[FGT 29.1, 29.3; YF 28.6, 28.7; TM 27.4; AF 26.2; LHL 23.6; DJG 5.3]

$$\oint \boldsymbol{B} \cdot d\boldsymbol{l} = \mu_0 I_{\text{in}}$$

for closed integration curve enclosing stationary current I_{in}. Is valid for *arbitrary* closed curve and *arbitrary* current I.
Sign on the current according to the right hand rule.

Ampere's law is *useful* when we have a suitable symmetry in the problem, so that the integral on the left hand side becomes easily solvable.

Magnetic field from infinitely long solenoid that is tightly wound:
Inside the solenoid:

$$B = \mu_0 n I$$

with I = current in wire and n = number of turns pr unit length. I.e., uniform magnetic field inside long solenoid.
Outside the solenoid, $B = 0$.

Next week: Gauss' law for the magnetic field. Summary, electrostatics and magnetostatics: Maxwell's equations. Different types of magnetism: Paramagnetism, diamagnetism, ferromagnetism.