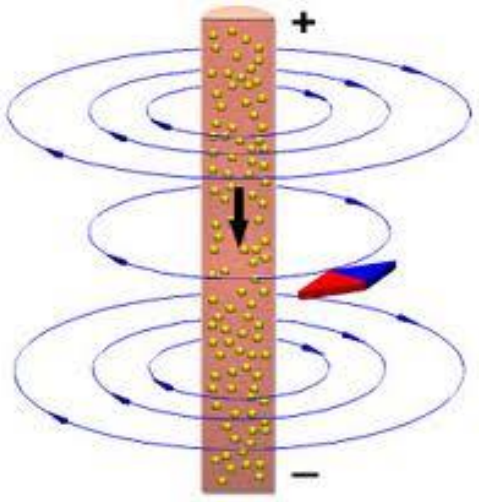
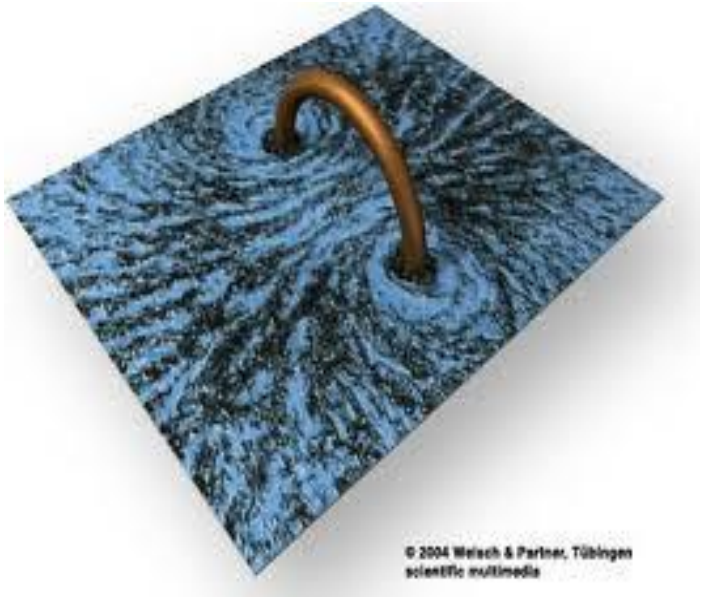
Fizika 2i

Mozgó töltések és áramok mágneses tere

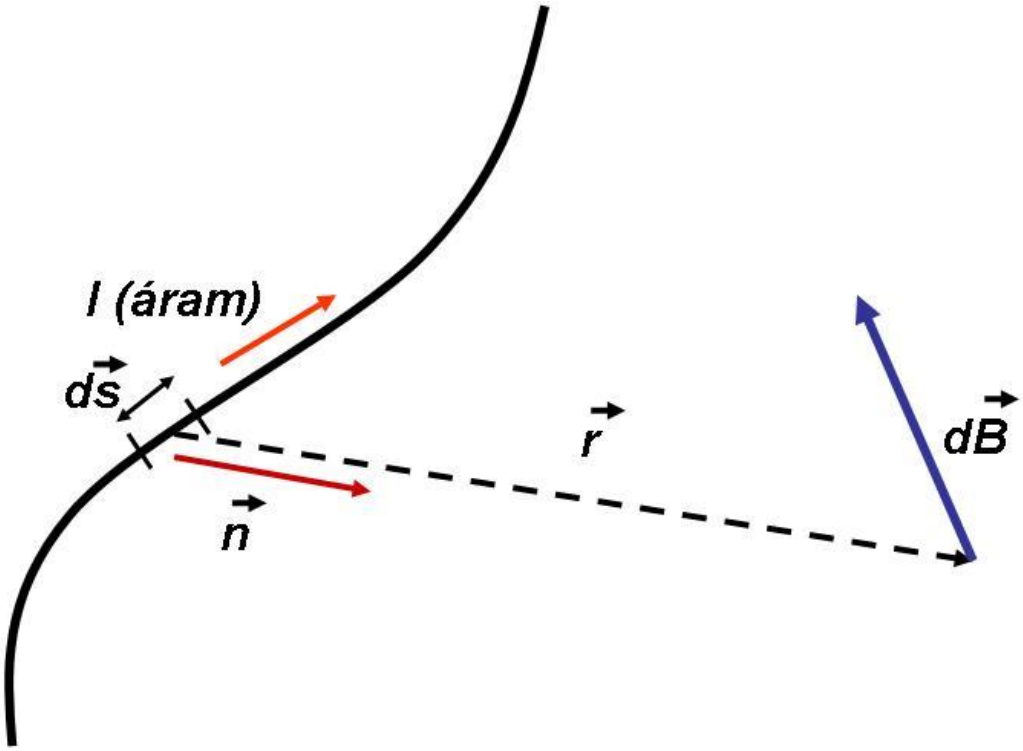
6. előadás

Az elektromos áram mágneses tere



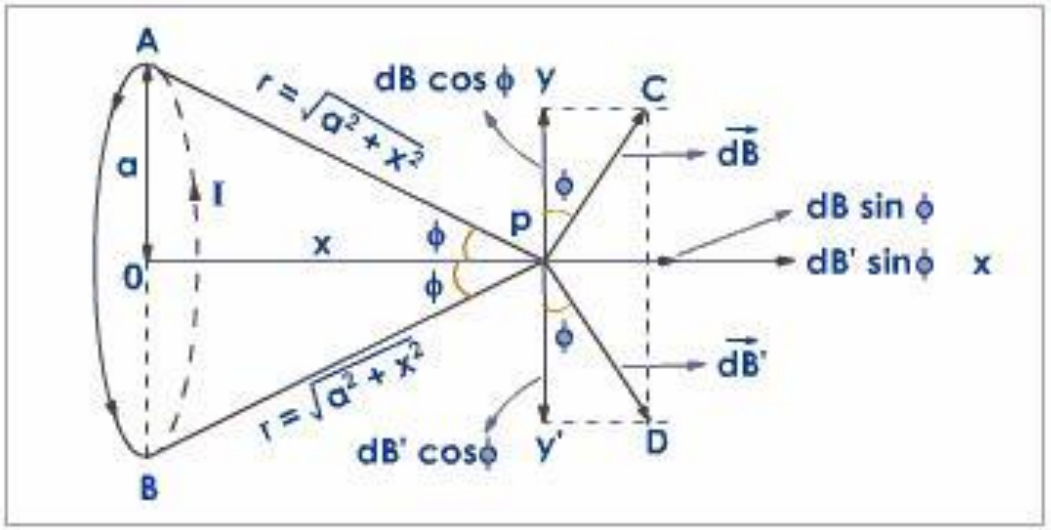


A Biot-Savart törvény



$$d\vec{B} = \frac{\mu_o}{4\pi} I \frac{d\vec{s} \times \vec{n}}{r^2}$$

Körvezető indukciós terének meghatározása a szimmetriatengelyen I.



$$dB = \frac{\mu_o}{4\pi} I \frac{ds}{r^2} = \frac{\mu_o}{4\pi} I \frac{ds}{a^2 + x^2}$$

$$dB_x = \frac{\mu_o}{4\pi} I \frac{ds}{a^2 + x^2} \sin\phi = \frac{\mu_o}{4\pi} I \frac{ds}{a^2 + x^2} \frac{a}{\sqrt{a^2 + x^2}} = \frac{\mu_o}{4\pi} I \frac{ds}{\left(a^2 + x^2\right)^{3/2}} \cdot a$$

$$B(x) = \frac{\mu_o}{2} \frac{Ia^2}{\left(a^2 + x^2\right)^{3/2}} \qquad \text{illetve} \qquad \vec{B} = \frac{\mu_o}{2\pi} \frac{\vec{\mu}}{\left(a^2 + x^2\right)^{3/2}}$$

Spec. eset:

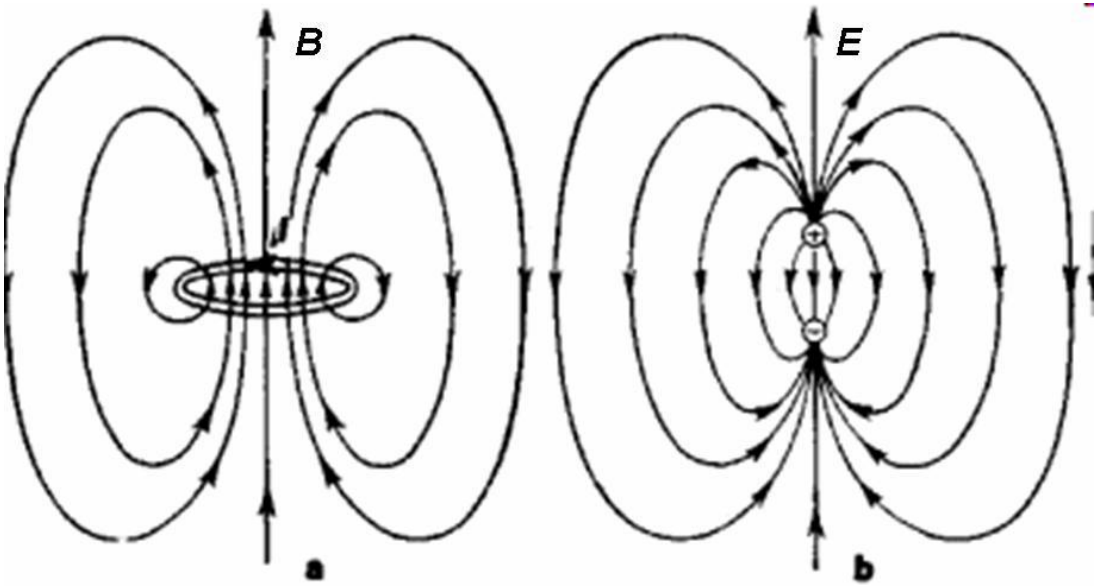
$$B(x=0) = \frac{\mu_o}{2} \frac{I}{a}$$

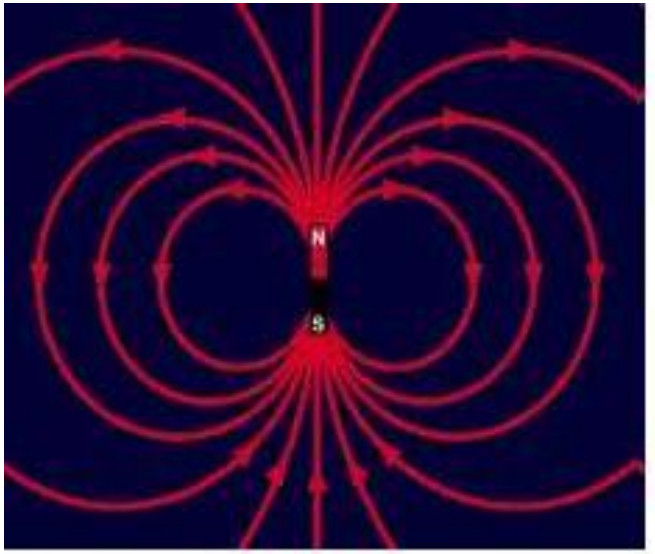
Körvezető indukciós terének meghatározása a szimmetriatengelyen II.

Spec. eset: $B(x=0)=\frac{\mu_o}{2}\frac{I}{a}$

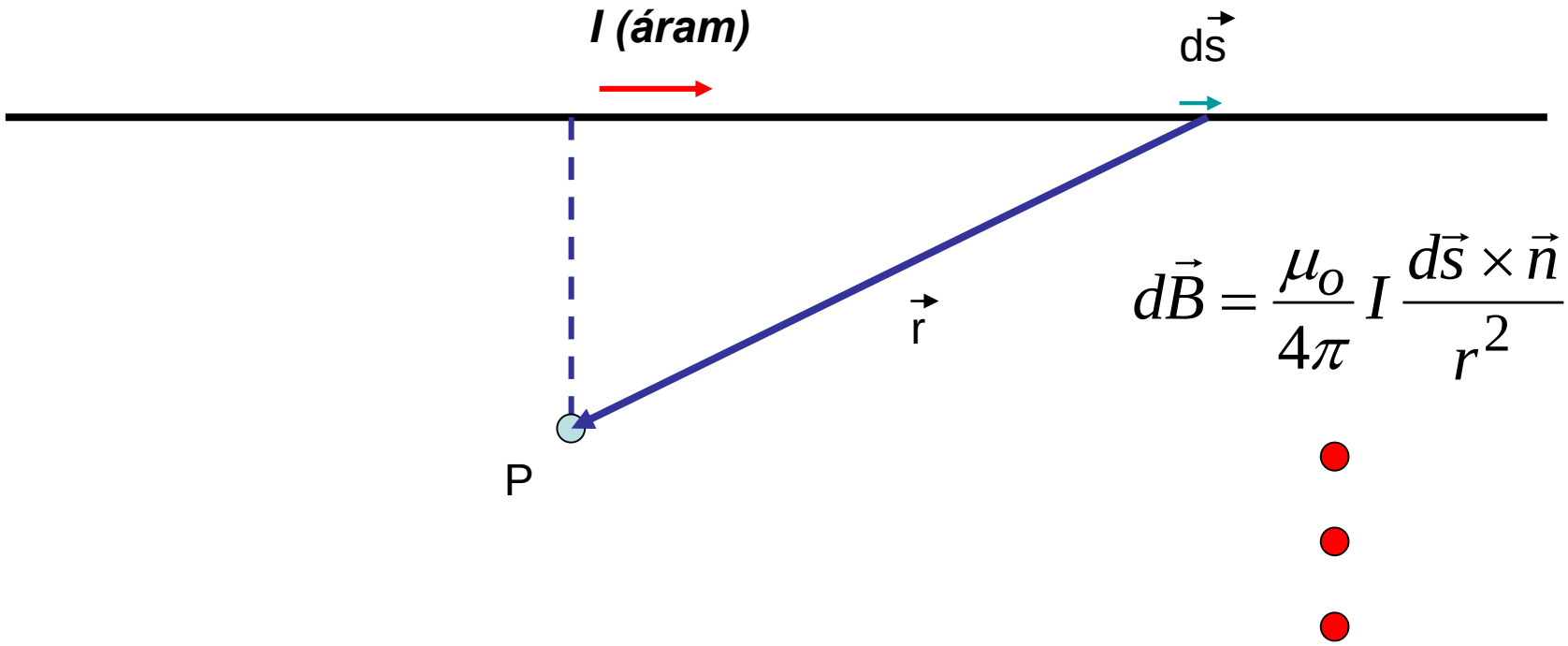
$$\vec{B}=\frac{\mu_o}{2\pi}\frac{\vec{\mu}}{\left(a^2+x^2\right)^{3/2}}$$

→ x >> a: ***B ~ 1/x³***

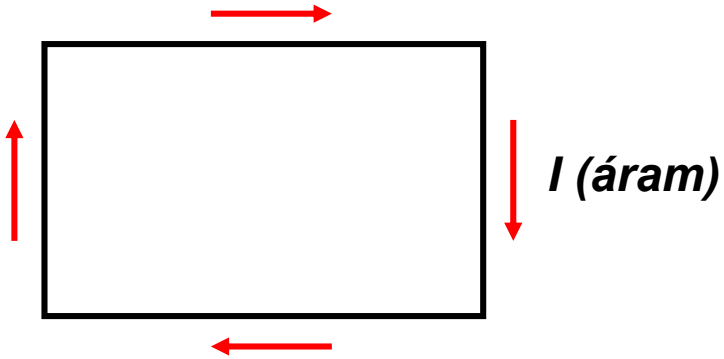




Példa: a ∞ hosszú vezető indukciós tere (Biot-Savart)

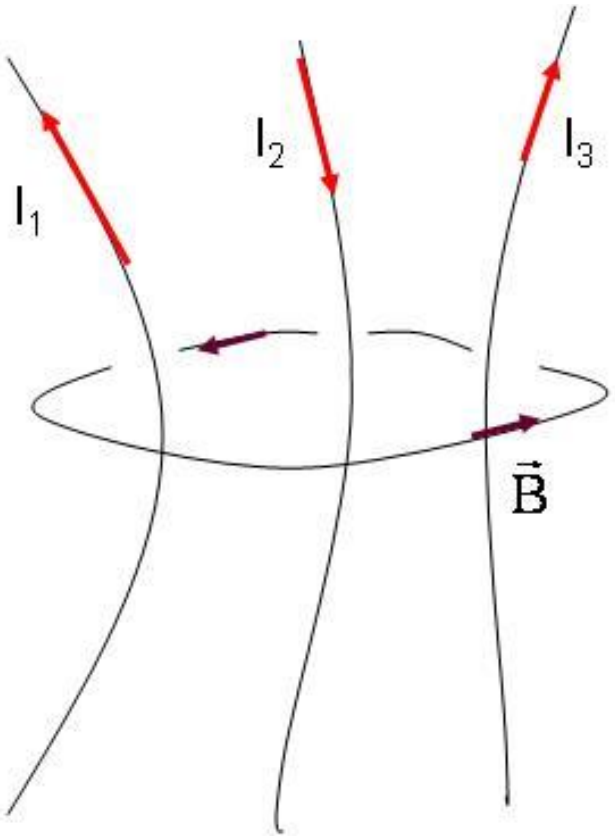


$$d\vec{B} = \frac{\mu_o}{4\pi} I \frac{d\vec{s} \times \vec{n}}{r^2}$$



B=? a keret közepén

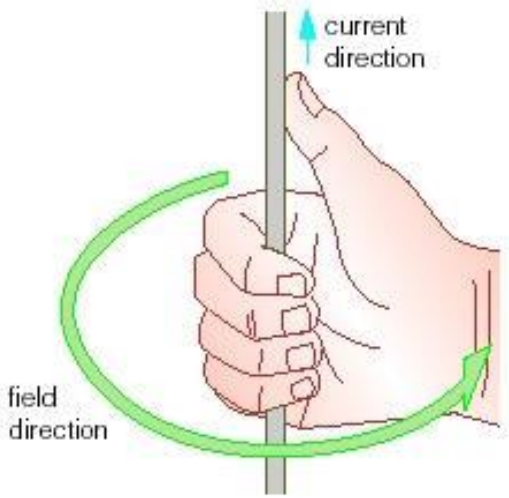
Ampère – törvény I.

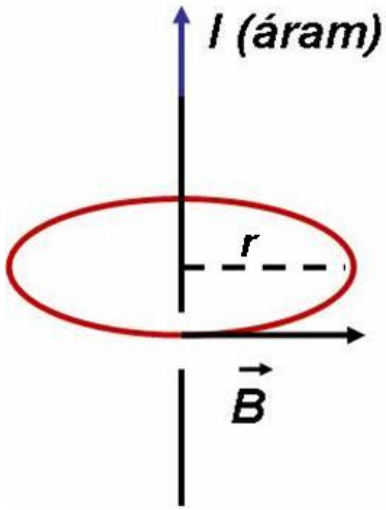


$$\oint_s \vec{B} d\vec{s} = \mu_o \sum_j I_j$$

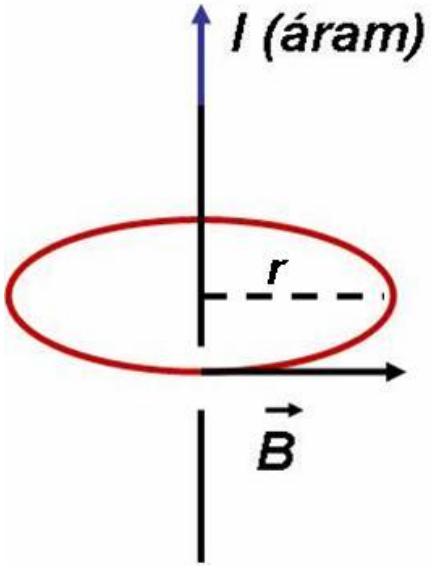
Σ I = I_1 - I_2 + I_3

jobbkéz-szabály:





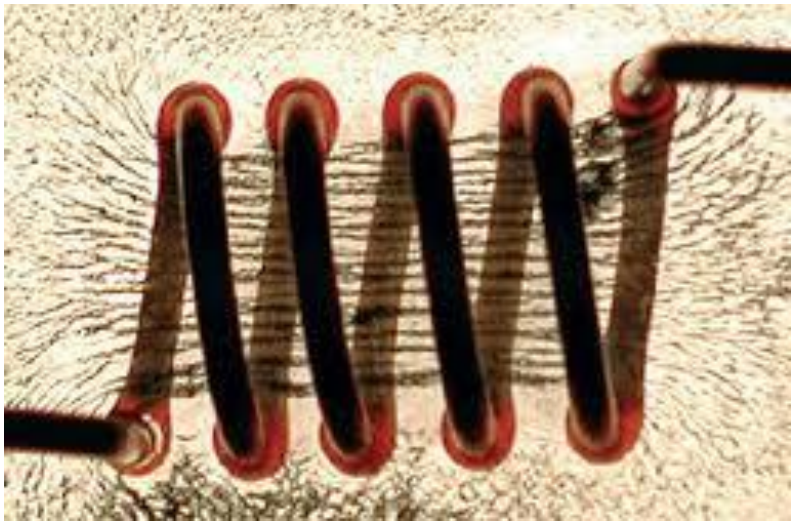
Ampère – törvény II.

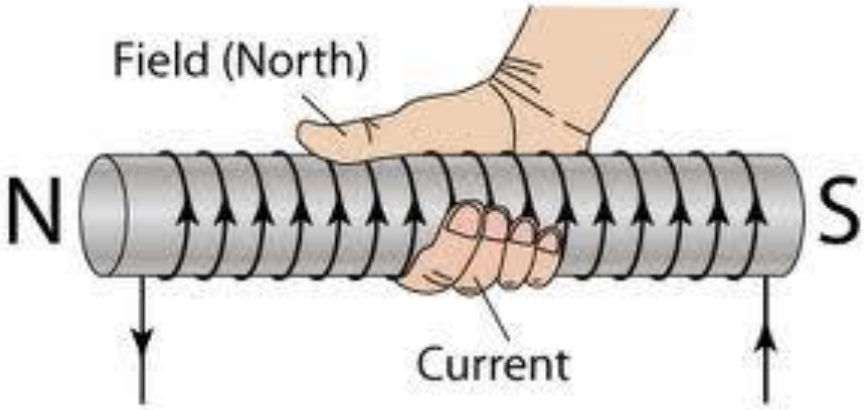


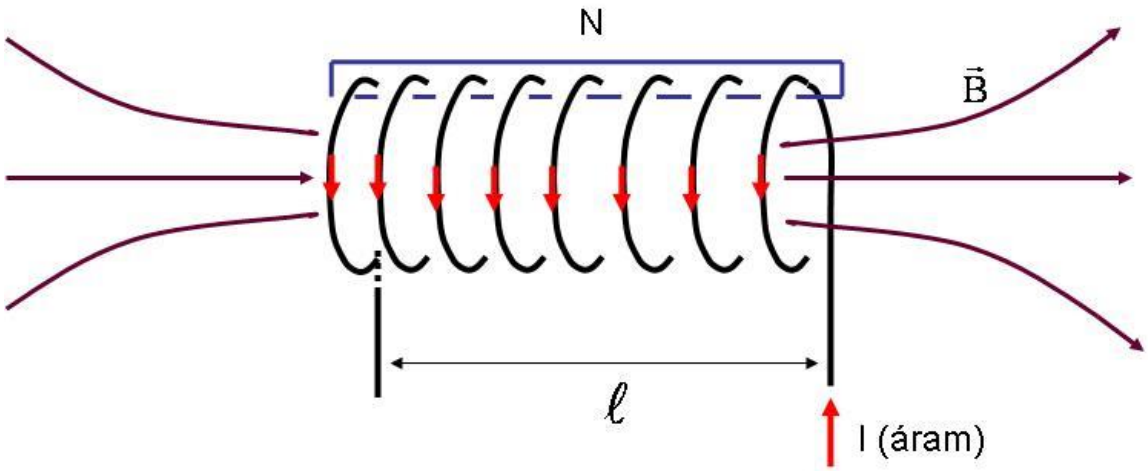
$$\oint_s \vec{B} d\vec{s} = \mu_o \sum_j I_j \longrightarrow \oint_s \vec{B} d\vec{s} = 2r\pi B \quad \text{ill.} \quad \mu_o \sum_j I_j = \mu_o I$$

$$2r\pi B = \mu_o I \quad \text{azaz} \quad B = \frac{\mu_o I}{2r\pi}$$

Ampère – törvény III.



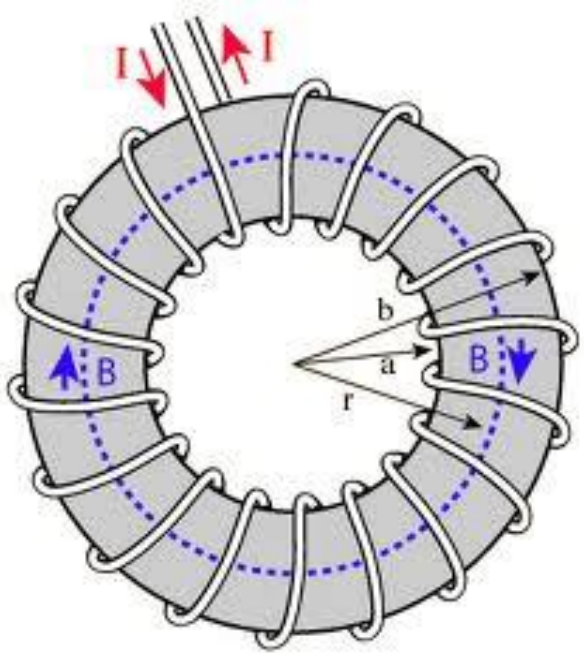


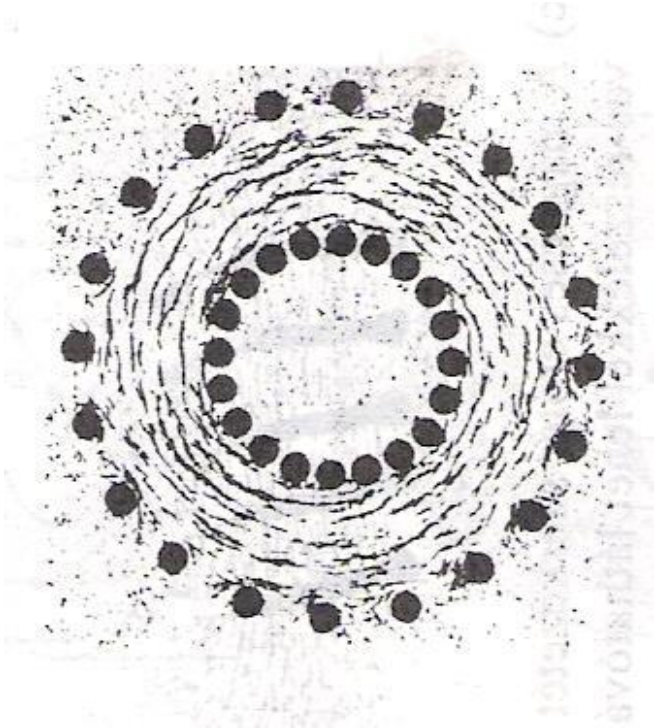


$$\oint_S \vec{B} d\vec{s} = \mu_o \sum_j I_j$$

$$B = \frac{\mu_o N I}{\ell}$$

Ampère – törvény IV.

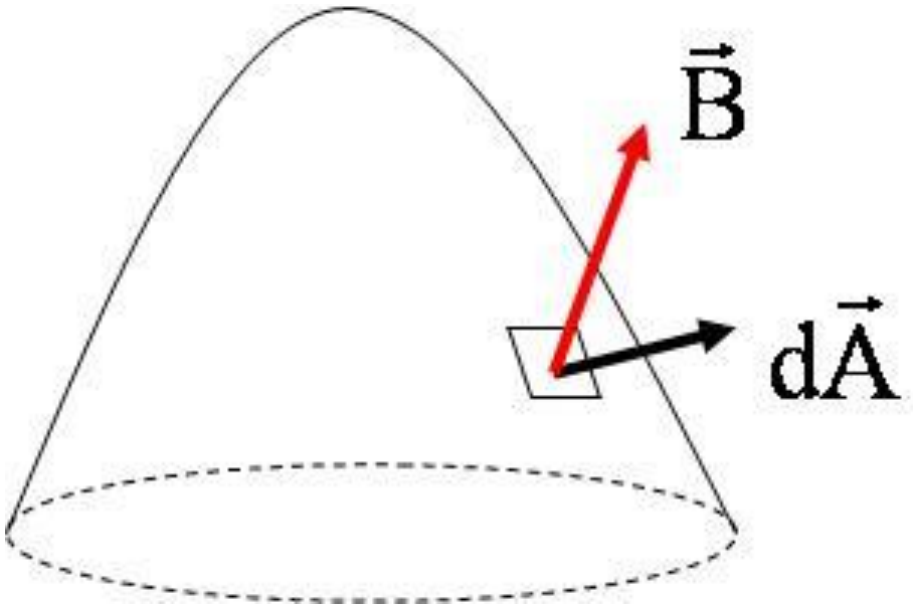




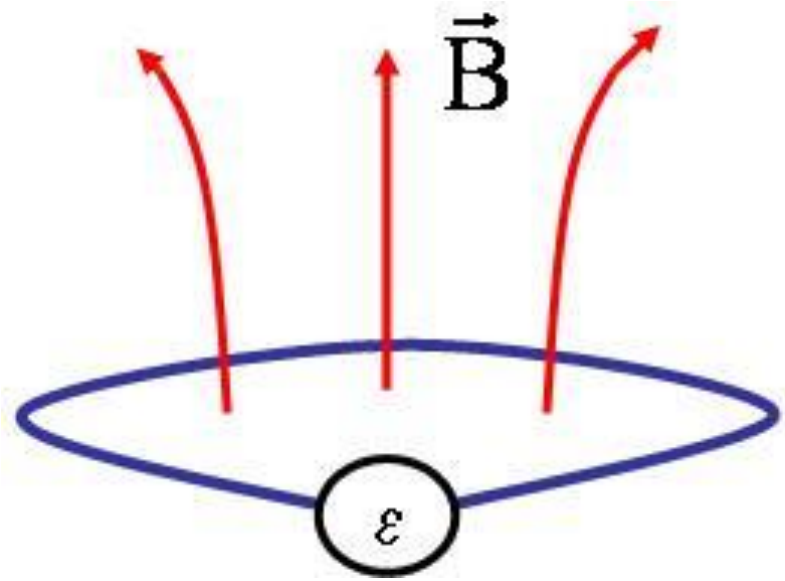
$$B = \frac{\mu_o N I}{2 r \pi}$$

Indukció I.

A mágneses fluxus: $\Phi_m = \int_A \vec{B} d\vec{A}$



Indukció II.

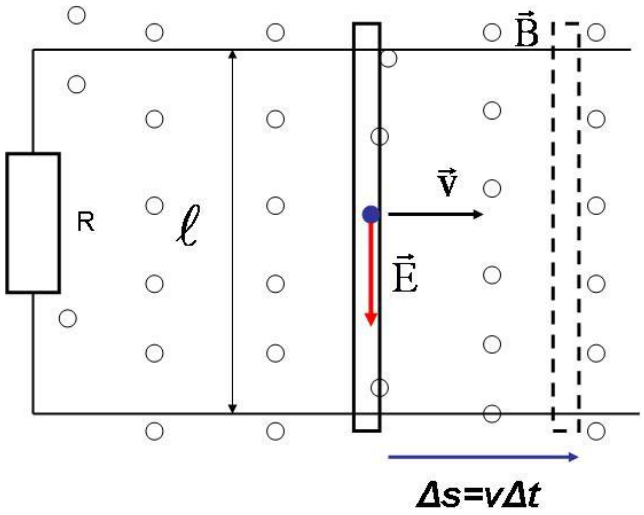


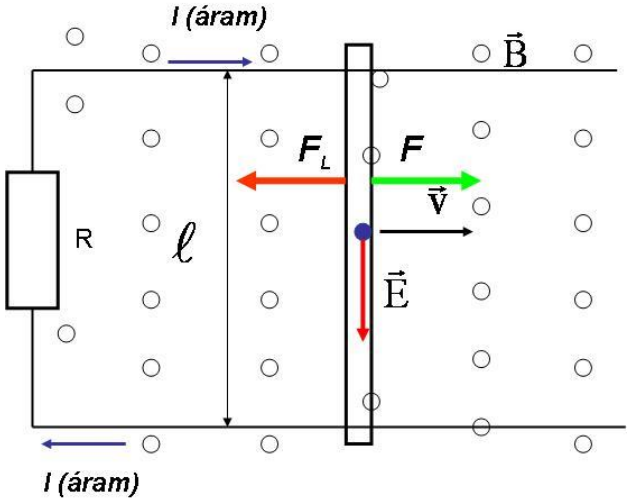
Elektromotoros erő $\varepsilon = \oint \vec{E} d\vec{s}$

$$\varepsilon = -\frac{d\Phi_m}{dt}$$

Lenz törvény

Indukció III.



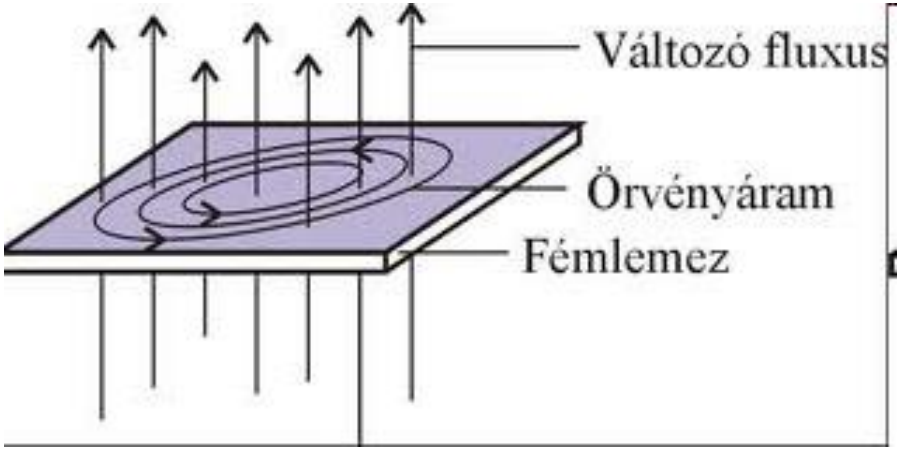


$$\Delta\Phi_m = B\ell v\Delta t \longrightarrow \left|\varepsilon\right| = \frac{B\ell v\Delta t}{\Delta t} = B\ell v$$

$$I = \frac{B\ell v}{R} \qquad F_L = BI\ell = \frac{B^2\ell^2 v}{R} \qquad P = F_L v = \frac{B^2\ell^2 v^2}{R}$$

$$P = I^2 R = \left(\frac{B\ell v}{R}\right)^2 R = \frac{B^2\ell^2 v^2}{R}$$

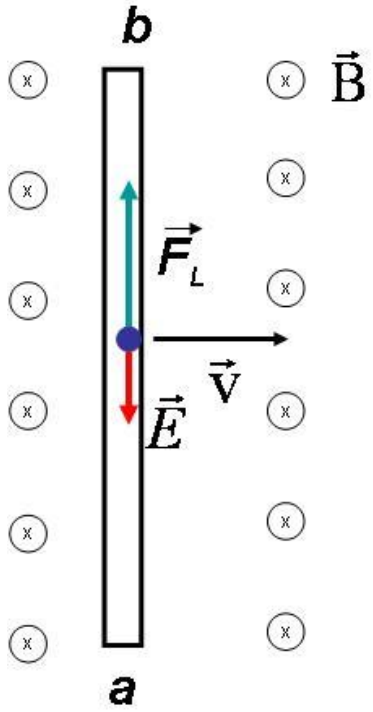
Örvényáramok



Indukciós sütő
Indukciós fék
Villanyóra számlálója
.
.
.

+ kísérlet

Indukció IV.

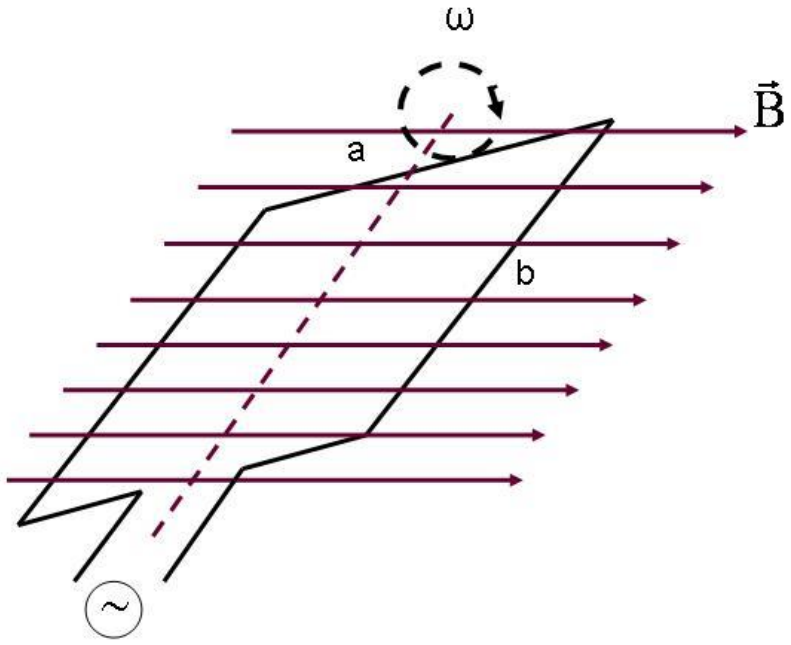


$$qE = qvB \quad \Rightarrow \quad E = vB$$

$$\varepsilon = V_{ab} = E\ell = vB\ell$$

Példa: helikopter rotorja

Váltakozó feszültségű generátor



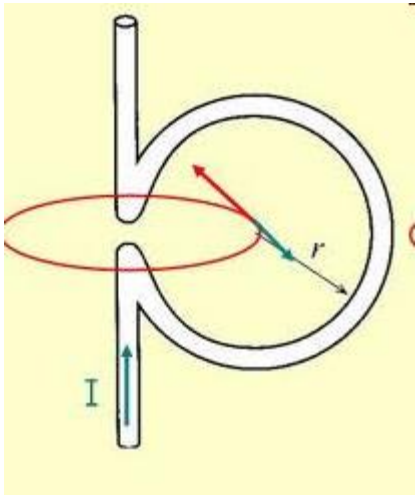
V (indukált feszültség)

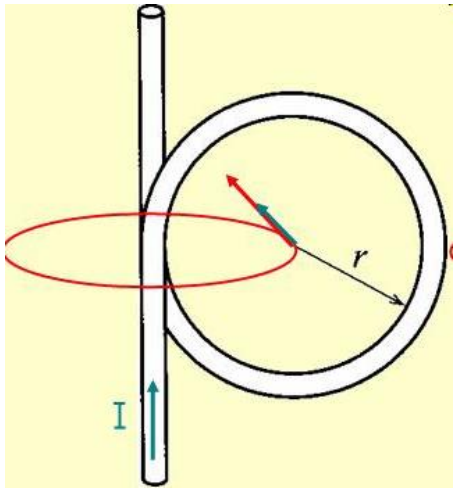
$A = ab$

$\Phi_m = BA\cos(\omega t)$

$$\varepsilon = -\frac{d\Phi_m}{dt} = V(t) = BA\omega\sin(\omega t) = V_o\sin(\omega t)$$

Példák:





+