4 Nov 2002 E/Z

Ch 5 Magnetostatics - Lecture notes

Magnetic part of

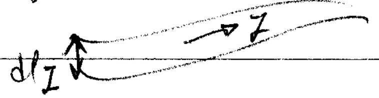
p.206 Lorentz force $\vec{F} = q(\vec{E} + \vec{v}\times\vec{B})$ does no work $W = \int \vec{F}\cdot d\vec{l}$
because $\vec{F}_{mag} \perp \vec{v} \parallel d\vec{l}$

★ $\vec{F}_{mag} = q\vec{v}\times\vec{B} = \int I\, d\vec{l}\times\vec{B} = \int(\vec{J}\times\vec{B})\,d\tau = \int(\vec{K}\times\vec{B})\,da$

where $d\vec{l}$ = path element along the current $I = \frac{dq}{dt}$

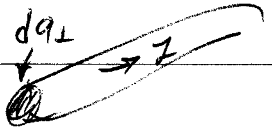
209 $I = \frac{dq}{dt} = \frac{dq}{dx}\frac{dx}{dt} = \lambda v$ where $\lambda = \frac{dq}{dx}$ = line charge

211 ° Surface current density $\vec{K} = \frac{d\vec{I}}{dl_\perp} = \frac{\text{current}}{\text{length}}$ where $dl_\perp$ is the width of the current ribbon



$\vec{K} = \sigma\vec{v}$ where $\sigma = \frac{\text{charge}}{\text{area}}$

212 ° volume current density $\vec{J} = \frac{d\vec{I}}{da_\perp} = \frac{\text{current}}{\text{area}}$ where $da_\perp$ is the cross section of a tube of current



$J = \rho\vec{v}$ where $\rho = \frac{\text{charge}}{\text{volume}}$

ELECTROSTATICS: stationary charges → constant E fields $\oint \vec{E}\cdot d\vec{a} = \frac{q(r)}{\epsilon_0}$

p.205 MAGNETOSTATICS: steady CURRENTS → constant B fields: $\oint \vec{B}\cdot d\vec{l} = \mu_0 I(r)$

$\vec{\nabla}\times\vec{B} = \mu_0 J(r)$

ELECTROSTATIC SCALAR POTENTIAL V: $\vec{E} = -\vec{\nabla}V$

234 Magnetostatic VECTOR potential $\vec{A}$: $\vec{B} = \vec{\nabla}\times\vec{A}$ $\vec{\nabla}\cdot\vec{B} = 0$

BC: $E_\parallel$ = continuous (so is V) $B_\perp$ = continuous (so is $\vec{A}$)

240 $\Delta E_\perp = \frac{\sigma}{\epsilon_0} = -\Delta\left(\frac{\partial V}{\partial n}\right)$ $\Delta B_\parallel = \mu_0 K = -\Delta\left(\frac{\partial A}{\partial n}\right)$