EE 331 - LECT. 35 APR. 22, 2020

exam #3

overall, okay statiscally, but actual performance underwhelming. violated lots of basic math concepts. please figure out everything you did wrong mathematically. see me during office hours if you need help. will need to use same math skills for exam on magnetostatics.

new grading scheme:

- final exam, part 2 (comprehensive) - canceled
- final exam, part 1 → exam #4, 13% → 17%
- exam #3 score adjustment: new score = exam #3 score + $\frac{(\text{exam \#4 score}) - (\text{exam \#3 score})}{2}$

  e.g., e3 = 60, e4 = 80, new = 70, only for e4 > e3
- exam #4, 2 hrs but same length as other exams (4 problems on 4 pages)

magnetic forces

recall, elec field exerts force on a charge whether the charge is moving or stationary:

$$\bar{F}_e = Q\bar{E} \quad [N]$$

however, magnetic field only exerts force on a moving charge:

$$\bar{F}_m = Q(\bar{u} \times \bar{B}) \quad [N] \quad \text{(RHR)}$$

$\bar{u}$ = velocity of charge [m/s]

$\bar{F}_m$ ⊥ to both $\bar{u}$ & $\bar{B}$ $\quad \bar{B}$ ⊙ → $\bar{u}$

↓ $\bar{F}_m$

$\vec{F}_e$ vs $\vec{F}_m$ - differences important

$\vec{F}_e$: - indep of charge velocity
- in same dir as velocity
- work $= \int \vec{F}_e \cdot d\vec{l} = Q\int \vec{E}\cdot d\vec{l}$ → work done changes kinetic energy(KE)

$$KE = \frac{1}{2} m u^2 \quad [J]$$

$\vec{F}_m$: - depends on charge velocity
- perpendicular to dir of velocity
- work $= \int \vec{F}_m \cdot d\vec{l} = Q\int (\vec{u}\times\vec{B})\cdot d\vec{l} = 0$ → no work done so no change in kinetic energy

$$\text{final KE} = \text{init KE} \quad (\vec{F}_m \text{ perpendicular to } d\vec{l})$$

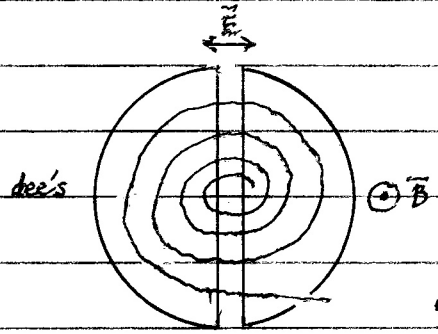
- $\vec{F}_m$ causes dir of moving charge to bend

lorentz force eq

total force on moving charge, $\vec{F} = \vec{F}_e + \vec{F}_m$:

$$\boxed{\vec{F} = Q(\vec{E} + \vec{u}\times\vec{B}) \quad [N]}$$ lorentz force eq (lfe)

basic cyclotron:



charged particle accelerator

life relates em force to mechanical force. recall, newton's 2nd law:

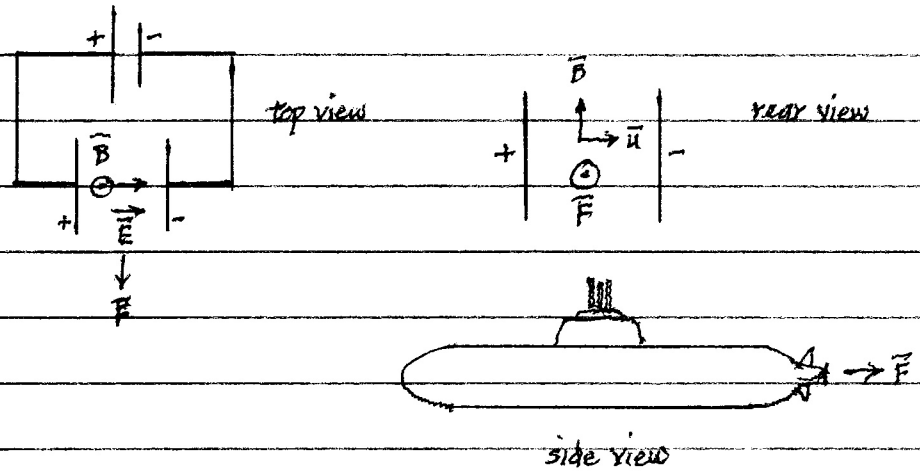
$$\bar{F} = m\bar{a} = m\frac{d\bar{u}}{dt} = m\frac{d^2\bar{r}}{dt^2} \quad [N]$$

equate lorentz force eq & newton's 2nd law:

$$Q(\bar{E} + \bar{u} \times \bar{B}) = m\frac{d\bar{u}}{dt}$$

for given $\bar{E}$ & $\bar{B}$, find $\bar{u}$ as func of time for charged mass. use $\bar{u}$ to find KE and position $\bar{r}$.

magneto hydrodynamic power (MHD)



positively charged particles move as a result of applied $\bar{E}$. $\bar{B}$ created by magnets causes particles to move in dir $\bar{u} \times \bar{B}$ to create water propulsion.

example #28

video of MHD power