Densities: Pg. 340

Formula Sheet – Physics 33 – Professor Young

$I = neV_d A$ $\quad J = \frac{I}{A}$ $\quad n = \frac{N}{V_l}$ $\quad Q = Ne$

$U = \sum \frac{kq_iq_j}{r_{i,j}}$

$\Delta U = q\Delta V$ $\quad V_E = qV$ $\quad (V = Ed)$

$\vec{F} = \frac{1}{4\pi\varepsilon_o}\frac{qQ}{r^2}\hat{r} = k\frac{q_1q_2}{r^2}\hat{r}$

$\vec{E} = \frac{1}{4\pi\varepsilon_o}\int\frac{dQ}{r^2}\hat{r}$ $\quad \vec{E} = k\frac{Q}{r^2}\hat{r}$

$V = \frac{1}{4\pi\varepsilon_o}\int\frac{dQ}{r}$ $\quad V = k\frac{Q}{r}$

$k = \frac{1}{4\pi\varepsilon_o}$

$\vec{F} = q\vec{v}\times\vec{B}$

$\vec{F} = q\vec{E}$

$\vec{F} = i\vec{l}\times\vec{B}$ $\quad \int I\,d\vec{l}\times\vec{B}$

$u = \frac{B^2}{2\mu_o}$

$u = \frac{1}{2}\varepsilon_o E^2$

$L = \frac{\mu_o N^2 A}{l}$ inductance factor

$\Delta V = -\int\vec{E}\cdot d\vec{r}$ $\quad V = Ed$

$\vec{E} = -\vec{\nabla}V$ $\quad E = \frac{dV}{dx}$ all dims

$R = \frac{\rho l}{A}$

$k = 9x10^9 N\cdot m^2/C^2$

$R = R_o(1+\alpha(T-T_o))$ (temperature - resistance)

$1T = 10^4$ Gauss

$\varepsilon_o = 8.85\ x\ 10^{-12}\ F/m$

$c = \sqrt{\frac{1}{\mu_o\varepsilon_o}} \approx 3x10^8 m/\sec$

$m_e = 9.11\times10^{-31}kg$

$m_p = 1.67\times10^{-27}kg$

$e = -1.6\times10^{-19}C$

$V = iR$

$C = \frac{k\varepsilon_o A}{d}$ dielectric constant, k=1 for vacuum, capacitance factory equation (plate capacitors!)

$L = \frac{N\phi}{i}$ - general, base

inductance fix inductance circuit

$V = -L\frac{di}{dt}$

$Q = CV_C$

$P = i\cdot V$

(derived w/ base/ amperes) $U = \frac{1}{2}CV^2$

$U = \frac{1}{2}Li^2$

transformer:

$\frac{V_{input}}{N_{input}} = \frac{V_{out}}{N_{out}}$

Primary Secondary

$I(t) = I_{max}\sin(\omega t)$

$I_{max} = \frac{V_{max}}{Z}$

$Z = \sqrt{R^2+(X_L+X_C)^2}$

RLC AC circuit

$f_{LC} = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}$

LC freq.

$\cdot = \cos\theta$

$X = \sin\theta$

$T_{RC} = R\cdot C$

$T_{LR} = \frac{L}{R}$

RC

Pos: charging
neg = discharging

$i(t) = Ie^{-t/RC}$

$i(t) = Ie^{-Rt/L}$ - discharging

$i(t) = I(1-e^{-Rt/L})$ - charging

$q(t) = Qe^{-t/RC}$ - decreasing (discharge)

$q(t) = Q(1-e^{-t/RC})$ - increasing (charging)

* damped R-L-C circuit!

$Q(t) = Q_{\max}e^{-\frac{Rt}{2L}}\cos(\omega' t+\varphi)$

$\omega' = \sqrt{\frac{1}{LC}-\frac{R^2}{4L^2}}$

LRC

$Q(t) = Q_{\max}\cos(\omega t+\varphi)$

LC circuit

$\omega = \sqrt{\frac{1}{LC}} = 2\pi f$

LC

$Z = \sqrt{R^2+(\chi_L-\chi_C)^2}$

$\chi_C = \frac{1}{\omega C}$

$\chi_L = \omega L$

$\tan\phi = \frac{\chi_L-\chi_C}{R}$

$\mu_o = 4\pi\ x\ 10^{-7}$ T-m/A

dipole moment $\rightarrow |\vec{p}| = qd \rightarrow$ opposite of $\vec{E}$ direction

$\vec{m} = IA\hat{n}$ $\quad U_{dipole} = -\vec{p}\cdot\vec{E}_{ext}$

$\int\sin^2\theta\,d\theta$

$\sin^2\theta = \frac{1}{2}(1-\cos2\theta)$

$\cos^2\theta = \frac{1}{2}(1+\cos2\theta)$

$Ampere's\,Law: \oint\vec{B}\cdot d\vec{l} = \mu_o I_{enclosed}$

$Gauss's\,Law: \oint\vec{E}\cdot\hat{n}dA = \frac{Q_{enclosed}}{\varepsilon_o}$

$Faraday's\,Law: EMF = -\frac{d}{dt}\int\vec{B}\cdot\hat{n}dA = -\int\vec{E}\cdot d\vec{l}$

$Biot-Savart: \vec{B} = \frac{\mu_o}{4\pi}\int\frac{Id\vec{l}\times\vec{r}}{r^3}$

Taylor expansion

$(X+Y)^n = X^n\left(1+\frac{Y}{X}\right)^n \approx X^n\left(1+n\frac{Y}{X}\right)$

(used often for approx when $X \ll d$, etc.)

for deriving period: $X = A\cos(\omega t)$

$a = \frac{d^2x}{dt^2}$