HW 11

29 - 31 Coil $N = 350$

$d = 10.0\ cm$

$f = 60\ rev/s$

$B = 0.45\ T$

$$V_{rms} = \frac{\mathcal{E}_0}{\sqrt{2}}$$

$$= \frac{NBA\omega}{\sqrt{2}}$$

where $A = \pi d^2 = \pi (0.50 \times 10^{-1}\ m)^2$

$\omega = 2\pi f$

so

$$V_{rms} = \frac{\left[(350)(0.45T)(0.50 \times 10^{-1} m)^2 \times (60\ Hz)(2\pi)\right]}{\sqrt{2}}$$

$$= 3.30 \times 10^2\ V$$

V_{rms} is proportional to ω, so to double V_{rms}, we should double ω, or equivalently f

60 rev/s $\rightarrow$ 120 rev/s

29 - 37 transformer $V_p = 120\ V$, $N_p = 500$

$V_s = 8500\ V$

from 29-5

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

$$\rightarrow N_s = N_p \frac{V_s}{V_p}$$

$$= 500\ \frac{8500}{120}$$

$$= 3.54 \times 10^4$$

29 - 39 Step-up transformer

$V_p = 22\,V$

$V_s = 120\,V$

use (29-5)

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{120}{22}$$

and (29-6)

$$\frac{N_p}{N_s} = \frac{I_s}{I_p}$$

to get

$$\frac{V_s}{V_p} = \frac{I_p}{I_s} = \frac{120}{22}$$

or $$\frac{I_s}{I_p} = \frac{22}{120} = 0.18$$

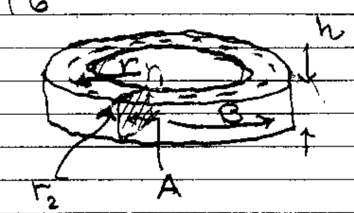
we could also use that power on both sides is same.

$$I_s V_s = I_p V_p$$

to get directly

$$\frac{I_s}{I_p} = \frac{V_p}{V_s}$$

30 - 16



flux

Need to know Φ_B through surface A

$\vec{B}$ is $\perp$ to A,

$$\Phi_B = \int \vec{B}\cdot d\vec{A} = h \times \int_{r_2}^{r_1} B(r)\,dr$$

To get B(r) use Ampere's law to circular path of radius r

$$\int \vec{B}\cdot d\vec{l} = \frac{I_{encl}}{\mu_0}$$

$$B(2\pi r) = \mu_0 N I$$

$$B = \frac{\mu_0 N I}{2\pi r}$$

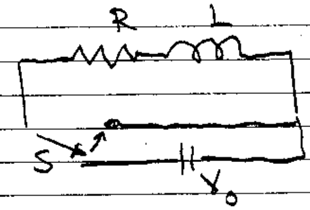
Then

$$\Phi_B = \frac{\mu_0 N I}{2\pi} h \int_{r_1}^{r_2} \frac{1}{r}\,dr$$

$$= \frac{\mu_0 N I h}{2\pi} \ln\frac{r_2}{r_1}$$

Self Inductance: $L = \frac{N\Phi}{I} = \frac{\mu_0 N^2 h}{2\pi} \ln\frac{r_2}{r_1}$

30-29



(Fig 30-5a)

a) Energy stored in L as a function of time.

current in circuit (after S connects V_0)

Eq (30-9) $I = \frac{V_0}{R}\left(1 - e^{-t/\tau}\right)$

where $\tau = \frac{L}{R}$ is the time constant

energy stored

$U_L = \frac{1}{2} L I^2$ (Eq 30-6)

$= \frac{1}{2}\frac{L V_0^2}{R^2}\left(1 - e^{-t/\tau}\right)^2$

b) when is $U_L = 0.99\, U_{max}$?

$0.99\, U_{max} = \left(\frac{L V_0^2}{2R^2}\right)\left(1 - e^{-t/\tau}\right)$

← this is U_{max}

$0.99 = \left(1 - e^{-t/\tau}\right)^2$

$1 - e^{-t/\tau} = \sqrt{0.99}$

$e^{-t/\tau} = 1 - \sqrt{0.99} = 5.01 \times 10^{-3}$

$t = -\tau \ln(5.01 \times 10^{-3}) = 5.3\tau$

30-35 LC circuit

$Q = Q_0$ at $t = 0$

At first time when

$\underset{\text{E in capac.}}{U_E} = \underset{\text{E in inductor}}{U_B}$

Call this t_0

a) $Q(0) = Q_0$

$Q(t) = Q_0 \cos(\omega t + \phi)$

so $\phi = 0$

then from page 764

$U_E = U_L$ says

$\frac{Q^2}{2C}\cos^2\omega t = \frac{Q^2}{2C}\sin^2\omega t$

need first t_0 for which

$\cos\omega t_0 = \sin\omega t_0$

which is

$\omega t_0 = \pi/4 \rightarrow t_0 = \frac{\pi}{4\omega}$

then $Q(t_0) = Q_0 \cos\frac{\pi}{4} = \frac{Q_0}{\sqrt{2}}$

b) $t_0 = \frac{\pi}{4\omega} = \left(\frac{2\pi}{\omega}\right)\frac{1}{4} = \left(\frac{1}{f}\right)\frac{1}{4} = \frac{T}{4}$

with T the period