Phy 2B 2/23

Monday, February 23, 2015 9:57 AM

Finish Ch 23
- Lenz's Law
- Inductors
- RL circuits
- Transformers

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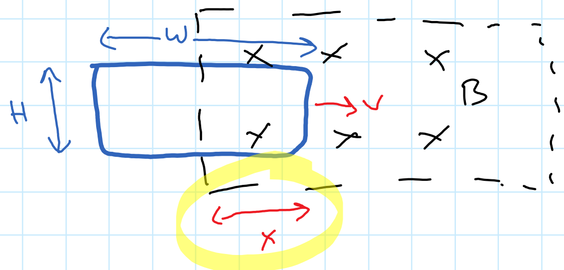
worksheet p. 141



$\Phi = BA$

$= BHx$

$\mathcal{E} = \frac{\Delta\Phi}{\Delta t} = \frac{\Delta(BHx)}{\Delta t}$

$= BH\frac{\Delta x}{\Delta t}$

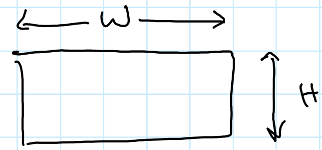
$= BHv$

	Φ	$\lvert\mathcal{E}\rvert = \left\lvert\frac{\Delta\Phi}{\Delta t}\right\rvert$
1	↑	same
2	↓	↓
3	same	same
4	↑	decreases to zero
5	same	↑
6	↑	↑
7	same	same (but opposite sign)
8	↑	↑

8	↑	↑
9	↑	same

Worksheet p. 142

Find the Φ_B for each case



$$\Phi_A = B\left(\frac{1}{4}WH\right)$$

$$\Phi_B = B\left(\frac{1}{2}WH\right)$$

$$\Phi_C = B\left(\frac{1}{2}WH\right)$$

$$\Phi_D = BHW$$

$$\Phi_E = BHW$$

$$\Phi_F = B\left(\frac{1}{2}HW\right)$$

$$\Phi_G = B\left(\frac{3}{4}HW\right)$$

$$\Phi_H = B\left(\frac{1}{2}HW\right)$$

Now, find $\mathcal{E}$ induced in each loop:

$$|\mathcal{E}_A| = BH\left(2\ \frac{cm}{s}\right)$$

$$\mathcal{E} = BHv$$

$$\mathcal{E} = \frac{\Delta\Phi}{\Delta t} = \frac{\Delta(BHx)}{\Delta t}$$

$\mathcal{E}_B = 0$ Nothing is changing

$$|\mathcal{E}_C| = BH\left(4\ \frac{cm}{s}\right)$$

$$\mathcal{E}_D = 0$$

$$\mathcal{E}_E = 0$$

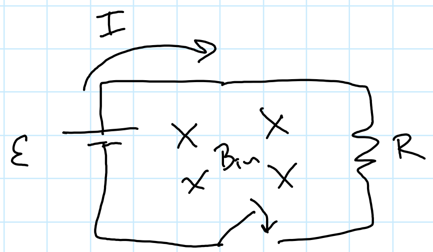
$$|\mathcal{E}_F| = BW\left(2\ \frac{cm}{s}\right)$$

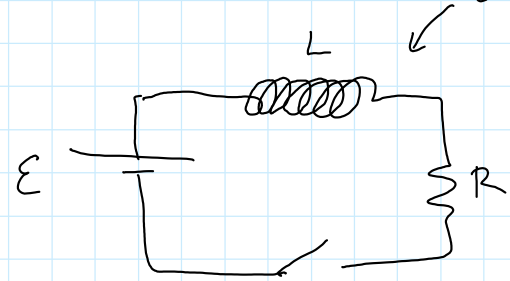
$$|\mathcal{E}_F| = BW \left(2\ \frac{cm}{s}\right)$$

$$|\mathcal{E}_G| = BH \left(6\ \frac{cm}{s}\right)$$

$$|\mathcal{E}_H| = 0$$

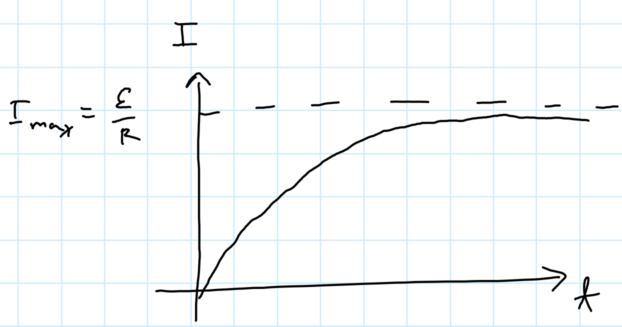
Inductance

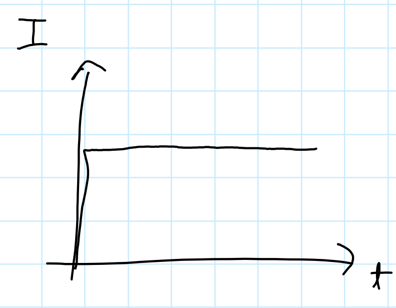




$$\mathcal{E}_L = N \frac{\Delta \Phi}{\Delta t} = L \frac{\Delta I}{\Delta t}$$

since
$$L = N \left| \frac{\Delta \Phi}{\Delta I} \right|$$



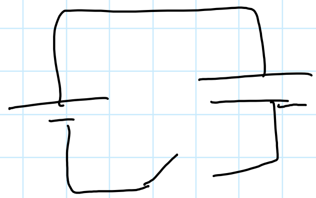


RL circuit

$$I = \frac{\mathcal{E}}{R}\left(1 - e^{-\frac{t}{\tau}}\right)$$

$$\tau = \frac{L}{R}$$

RC charging



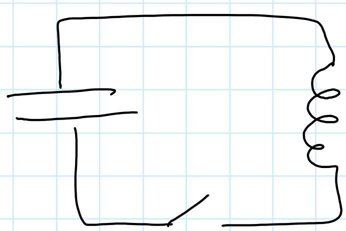
energy:

cap

$$U_c = \frac{1}{2} C V^2$$

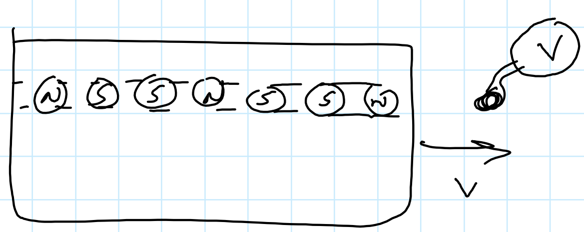
inductor

$$U_L = \frac{1}{2} L I^2$$

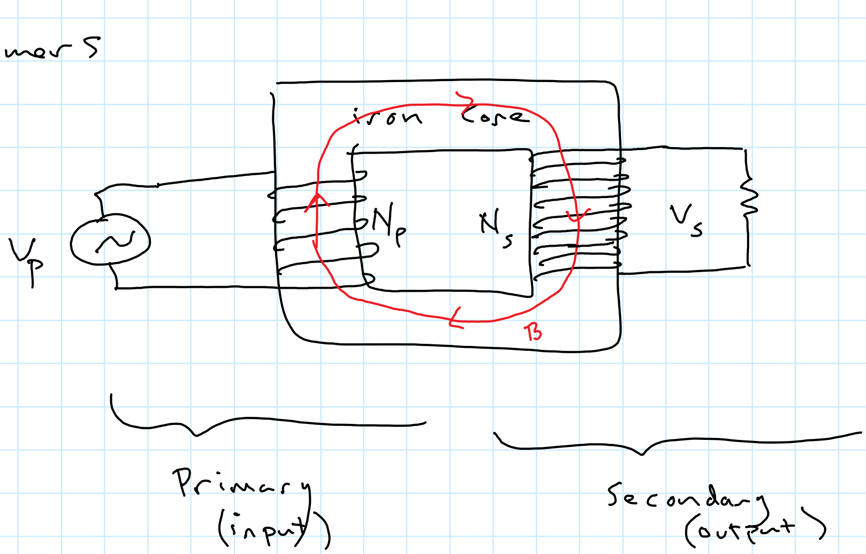


Applications

- Credit Cards - Mag. stripe
- Speakers & mics
- Motors & generators
- Hybrid cars (back emf)



Transformers



$V_s > V_p$ Step up transformer

$V_p > V_s$ step down transformer

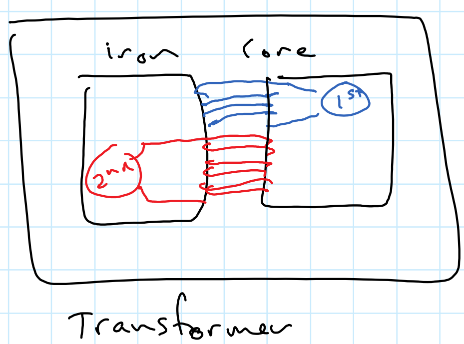
$P_p = P_s$ for ideal transformer

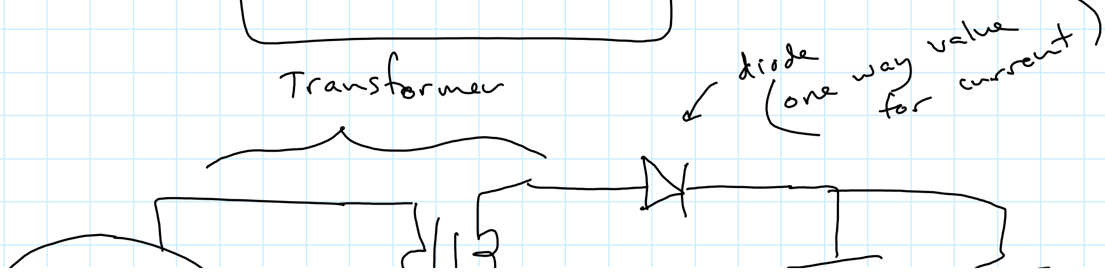
$I_p V_p = I_s V_s$

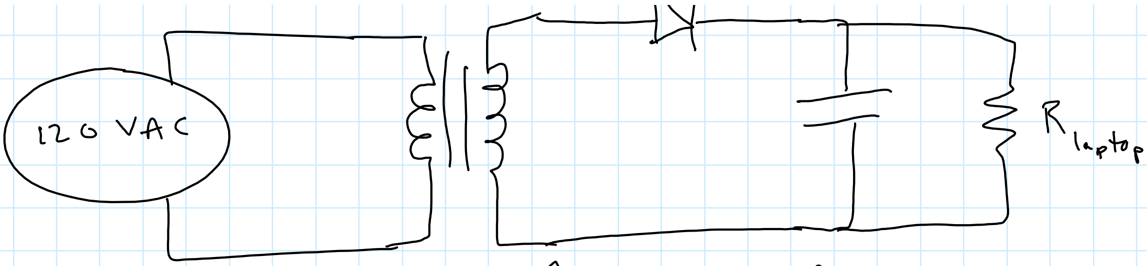
if $V_s > V_p$ then $I_s < I_p$

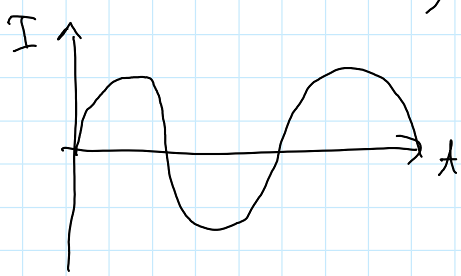
$$V_s = \frac{N_s}{N_p} V_p$$

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

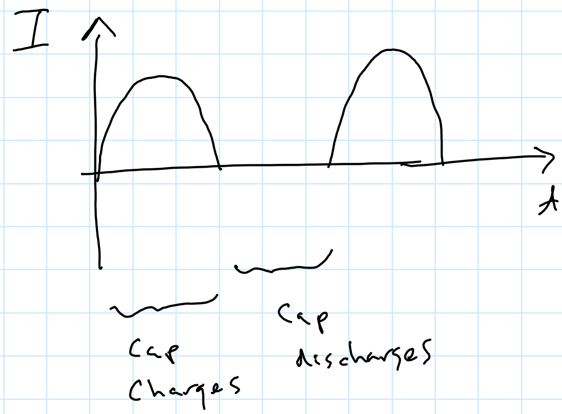






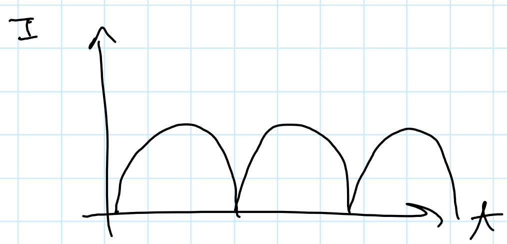


with 1 diode:

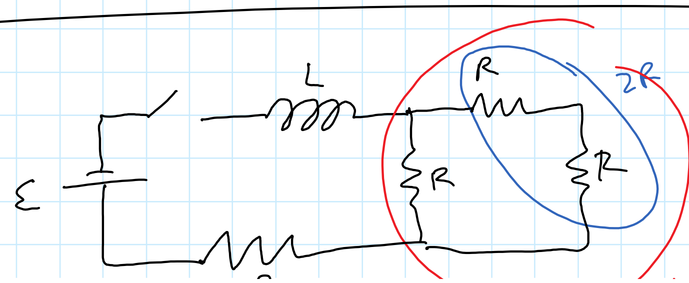


almost DC

with 4 diodes:



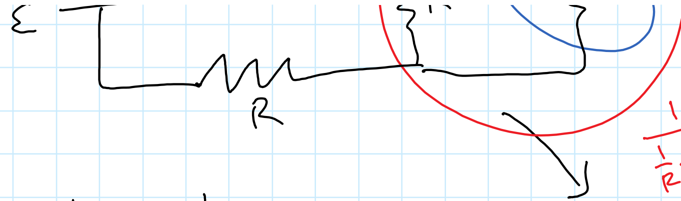
Prob 23-55



$\varepsilon = 6\ V$

$L = 37\ mH$

$R = 55\ \Omega$

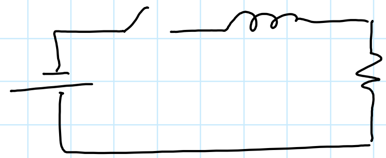


$R = 55\ \Omega$

$\frac{1}{\frac{1}{R}+\frac{1}{2R}}$

$\tau = \frac{L}{R} = \frac{L}{R_{eq}}$

find eq. circuit



$R_{eq} = R + \left(\frac{1}{\frac{1}{R}+\frac{1}{2R}}\right)$

I after a long time:

inductor has no effect on circuit:

$$I_{max} = \frac{\varepsilon}{R_{eq}}$$

$$I = I_{max}\left(1 - e^{-\frac{t}{\tau}}\right)$$

I at $t = 2\tau$

$$I = \frac{\varepsilon}{R_{eq}}\left(1 - e^{-\frac{2\tau}{\tau}}\right)$$

$$= \frac{\varepsilon}{R_{eq}}\left(1 - \frac{1}{e^2}\right)$$

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$N_p = 25$

$N_s = 750$

$V_s = 4800\ V$

$I_s = 0.012\ A$

$$V_p = \frac{N_p}{N_s} V_s = \frac{25}{750}(4800) = 160\ V$$

$$I_p = \frac{N_s}{N_p} I_s = \frac{750}{25}(0.012) = 0.36 \text{ A}$$