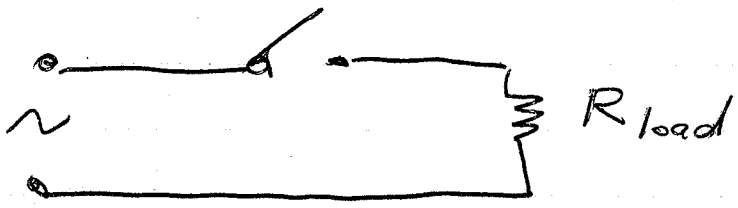
Phys 2426 2015-10-27 Lec 18

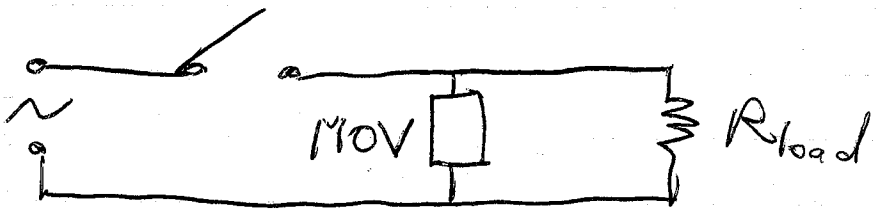
Review For Exam 2
Magnetism
EM Induction
AC Circuits

Overload Protection



Circuit Breaker opens ($R=\infty$) when current gets too large.
$R=\infty$ in series $\rightarrow$ $R_{eq}=\infty$
$I=0$

Surge Supression



MOV trips if V gets too large
$R_{MOV} \rightarrow 0$,
- conducts surge away from Load
- Trips circuit breaker
- Dies

Series RLC Circuit

Frequency, R, L, C, V_{RMS} overall

$$X_L = 2\pi f L$$
$$X_C = 1/2\pi f C$$
$$X = X_L - X_C$$

$$R \rightarrow Z = \sqrt{R^2 + X^2}$$

$$V_{rms} = I_{rms} Z$$

$$P = I^2 R$$

$$I_{max} = I_{rms}\sqrt{2}$$

Special Case: Resonance

$$X_L = X_C \rightarrow X = 0$$

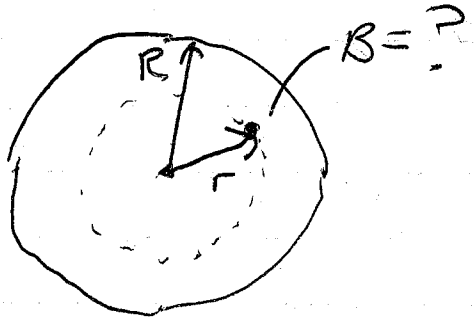
$$Z = R$$

$$2\pi f L = \frac{1}{2\pi f C}$$

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

(3)

Mag Field of thick wire



$$I = 2\ A$$

$$I_{enc} = I\left(\frac{A_{enc}}{A_{tot}}\right)$$

$$= I\left(\frac{r^2}{R^2}\right)$$

r = our position
R = radius of wire

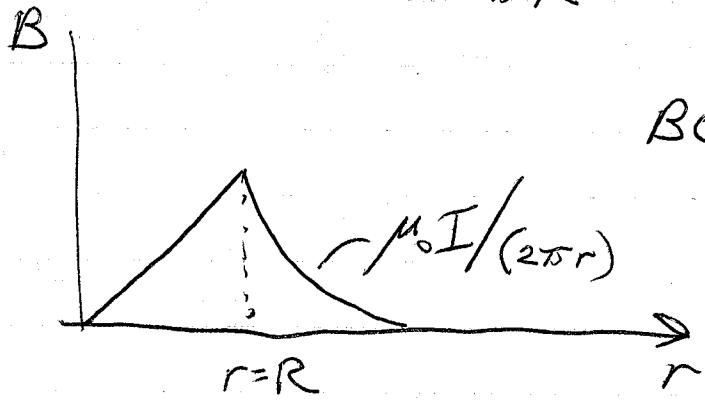
Ampere's Law $\quad \oint \vec{B} \cdot d\vec{\ell} = \mu_0 I_{enc}$

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

$$B = \frac{\mu_0 I}{2\pi R^2} r = \frac{\mu_0 I}{2\pi R}\left(\frac{r}{R}\right)$$

$\frac{\mu_0 I}{2\pi R}$ ↑ B @ surface

$\frac{r}{R}$ ↑ Fraction from center



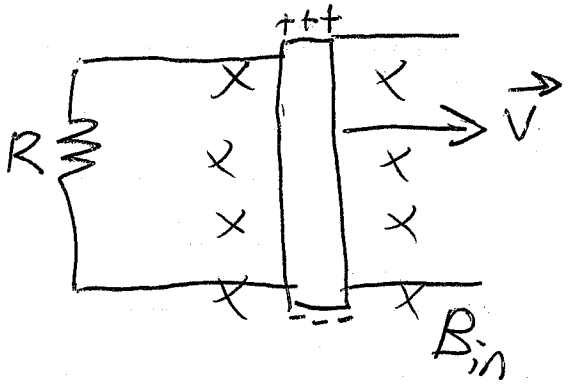
(14)

Induced EMF

$$|\mathcal{E}| = \frac{d\Phi_B}{dt} \longrightarrow \frac{d}{dt}(NBA\cos\theta)$$

$$\mathcal{E} = vBl$$

Motional EMF



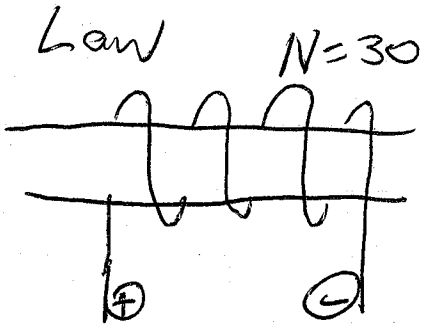
$\mathcal{E} = vBL$

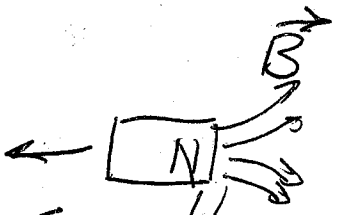
$\mathcal{E} = IR$

Force on ⊕ → Up

⊖ → Down

Lenz Law





Toss through coil

As the magnet arrives:

- B in coil increases
- B points right
- Coil Fights it
- B_{ind} = left
- Left wire is ⊕

(5)

Wind Turbine Generator

$$\mathcal{E} = NBA\omega \sin\theta$$

$$\tau = NBA\, I \sin\theta$$

$N = 145$

$A = 0.495\ m^2$

$\omega = 6\ rad/s = 6\ \frac{rad}{s}\left(\frac{1\ rev}{2\pi\ rad}\right)\left(\frac{60\ s}{1\ min}\right)$

$= 57\ rpm$

$B = 0.45\ T$

$\mathcal{E}_{max} = NBA\omega = 194\ V$

$R = 20\ \Omega$

$I = \frac{V}{R} = \frac{194\ V}{20\ \Omega} = 9.7\ A$

} $1880\ W$

τ needed

$\tau = NBAI = 313\ N\cdot m = 230\ ft\cdot lb$

$P = \tau \cdot \omega = (313\ N\cdot m)(6\ rad/s)$

$= 1878\ W$

⑥

	60 W Bulb		10 W LED
	$0.50	vs.	$4
	120 V	Voltage	120 V
$P=VI$	0.5 A	Current	0.0833 A
	240 Ω	Resistance	1440 Ω
	720 hr	Time in month	720 hr
	(0.06 kW)(720h) 43.2 kWh	Energy	(0.01 kW)(720 hr) 7.2 kWh
	$0.12/kWh	Rate	$0.12/kWh
	$5.18	Cost/Month	$0.86