Office hours this week

- Today: 1 – 2:30
- Tomorrow: 10:30 - 12

Second Midterm

- Next Wednesday, Nov. 16, 7 – 9 pm in Merrill 1
- Chapters 24 – 29 and labs 1 – 5.
- Bring a pen/pencil and a calculator (for arithmetic only)
- Exam will have a page of key equations.
- No homework or lab next week.
- Lab report due on Friday, Nov. 18, 5 pm.

Power

$$P = IV$$

Power dissipated by a resistor:

$$P = I^2 R$$

$$P = \frac{V^2}{R}$$

Self Inductance

- A changing current in one part of a current-carrying circuit can induce an emf *in the same circuit*.

$$\varepsilon = -L\frac{dI}{dt}$$

- *L* = self inductance, a geometric and materials property.
- Units – Henry (H) = Vs/A = Ωs

Capacitors and Inductors

Capacitor

- Stores charge and energy.

$$Q = CV$$

$$I = C\frac{dV}{dt}$$

- Energy:

$$U_C = \tfrac{1}{2}CV^2$$

- Energy density:

$$u_C = \tfrac{1}{2}\varepsilon_0 E^2$$

Inductor

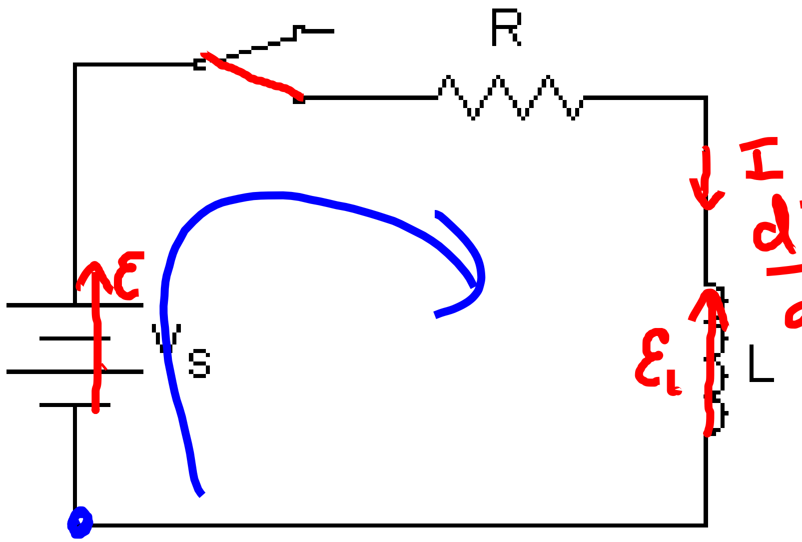
- Stores magnetic flux and energy.

$$N\Phi_B = LI$$

$$\varepsilon = -L\frac{dI}{dt}$$

- Energy:
- Energy density:

LR circuit



http://people.sinclair.edu/nickreeder/eet155/mod02.htm

I increases

$$\frac{dI}{dt} > 0$$

$$V_s - IR - L\frac{dI}{dt} = 0$$

$$V_s = IR + L\frac{dI}{dt}$$

$$IV_s = I^2R + LI\frac{dI}{dt}$$

$$\mathcal{E}_L = -L\frac{dI}{dt}$$

power generated by source = power dissipated by R + power into L

$$P = \frac{dV}{dt}$$

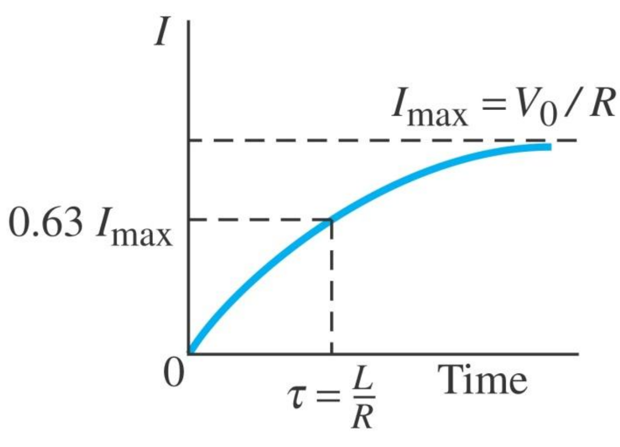


Figure 30.6b (b)

$$P_L = LI\frac{dI}{dt} = \frac{dU_L}{dt}$$

$$U_L = \int P_L\,dt = \int LI\frac{dI}{\cancel{dt}}\cancel{dt}$$

$$= \int_0^{I_f} LI\,dI$$

$$= L\frac{1}{2}I^2\Big|_0^{I_f}$$

$$= L\frac{1}{2}I_f^2$$

$$U_L = \frac{1}{2}LI^2$$

Solenoid

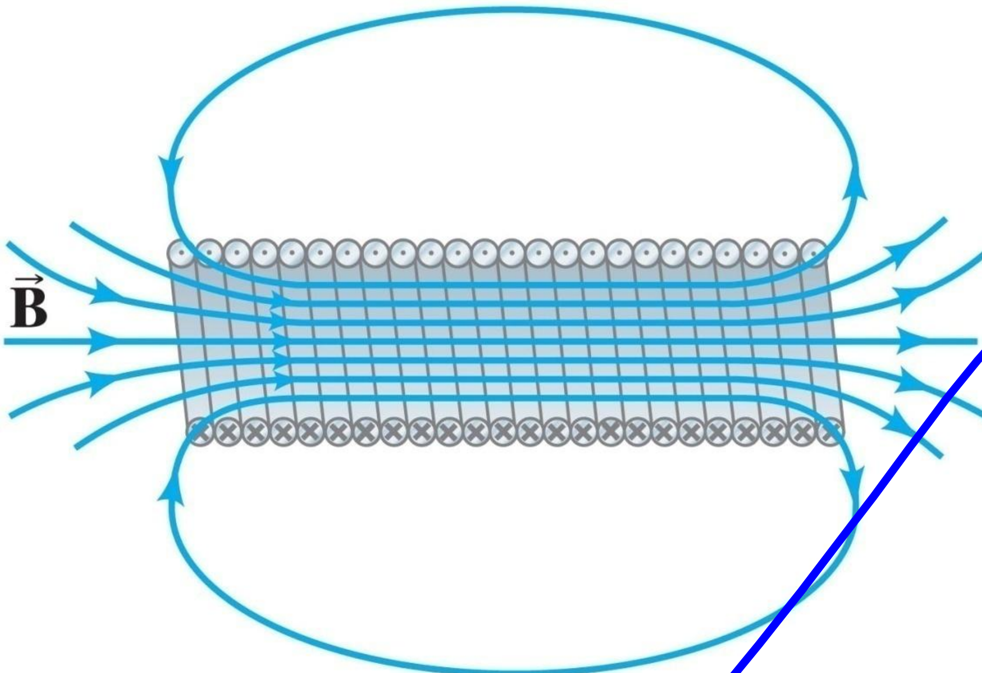


Figure 28.15b

$$B = \frac{\mu_0 N I}{l}$$

$$L = \frac{\mu_0 N^2 A}{l}$$

$$U_L = \frac{1}{2} L I^2 = \frac{1}{2}\frac{\mu_0^2 N^2 A}{\ell^2} I^2 \frac{\ell}{\mu_0} = \frac{1}{2}\left(\frac{\mu_0^2 N^2 I^2}{\ell^2}\right)\frac{A\ell}{\mu_0} = \frac{1}{2}\frac{B^2 (A\ell)}{\mu_0}$$

$$u_B = \frac{U_L}{Vol} = \frac{U_L}{A\ell} = \frac{1}{2}\frac{B^2}{\mu_0}$$

Capacitors and Inductors

Capacitor

- Stores charge and energy.

$$Q = CV$$

$$I = C\frac{dV}{dt}$$

- Energy:

$$U_C = \tfrac{1}{2}CV^2$$

- Energy density:

$$u_E = \tfrac{1}{2}\varepsilon_0 E^2$$

Inductor

- Stores magnetic flux and energy.

$$N\Phi_B = LI$$

$$\varepsilon = -L\frac{dI}{dt}$$

- Energy:

$$U_L = \tfrac{1}{2}LI^2$$

- Energy density:

$$u_B = \tfrac{1}{2}\frac{B^2}{\mu_0}$$

Capacitors and Inductors in AC Circuits

Capacitor

$$V_{\max} = I_{\max} X_C$$

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

- X_C = "capacitive reactance"
- Current leads voltage (ICE)

Inductor

$$V_{\max} = I_{\max} X_L$$

$$X_L = \omega L$$

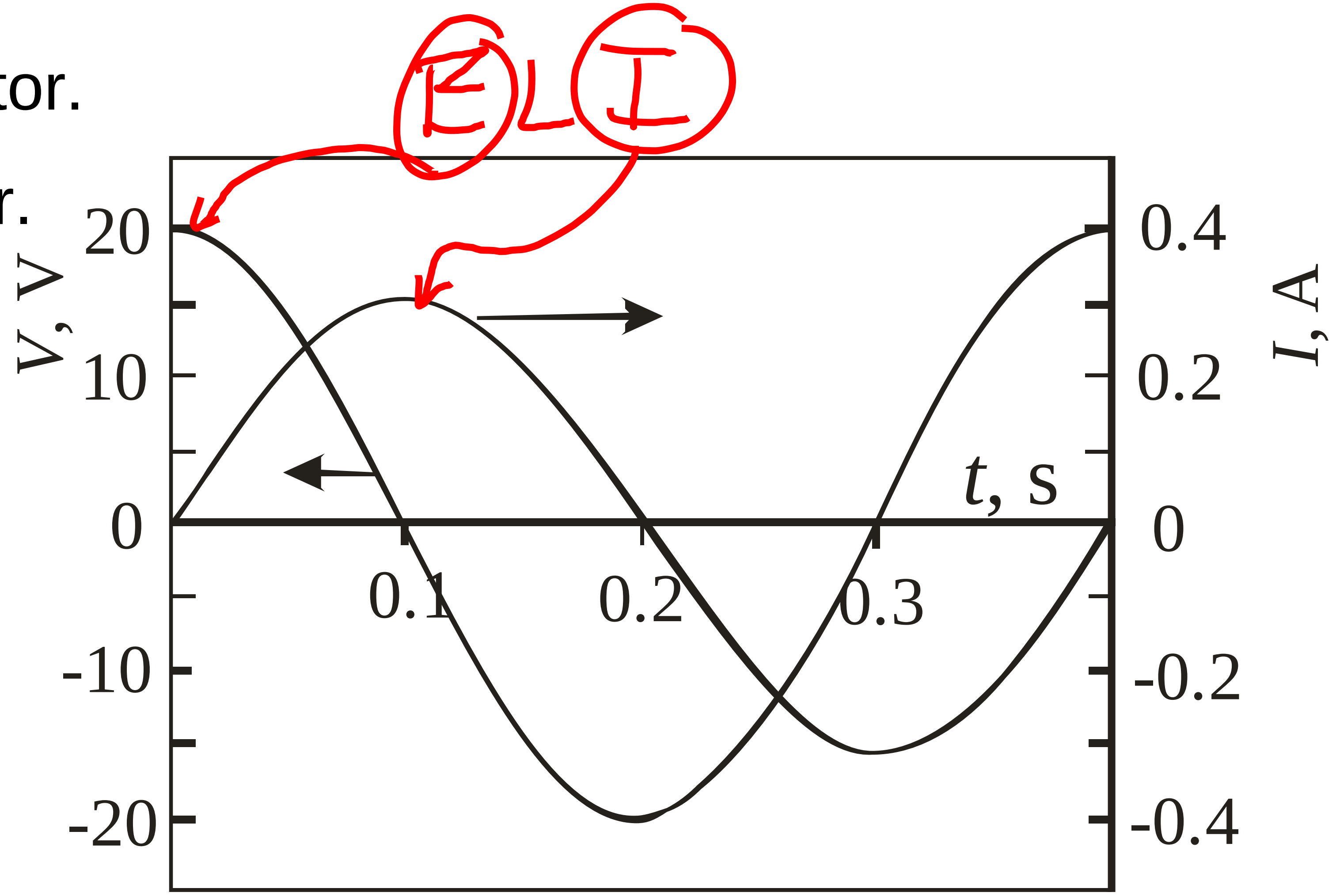
- X_C = "capacitive reactance"
- Current lags behind voltage (ELI)

The figure shows the voltage and current for a(n)

1) inductor.

2) capacitor.

3) resistor.



If you double the frequency in the circuit, the inductive reactance of the inductor

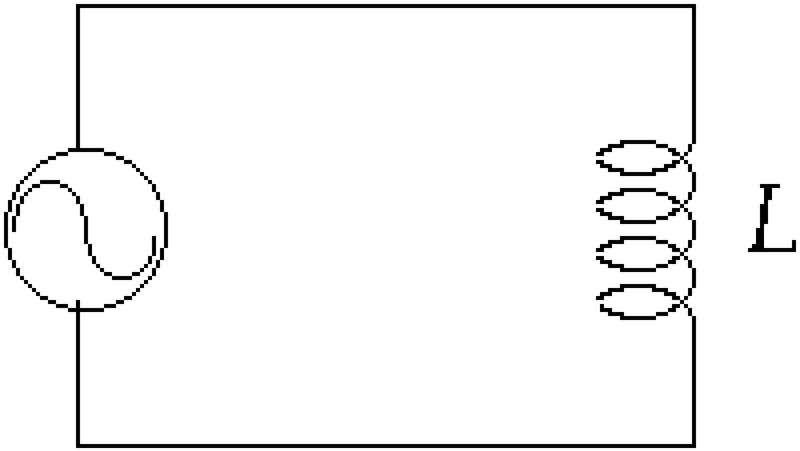
1) increases by a factor of 2.

2) does not change.

3) decreases by a factor of 2.

4) increases by a factor of 4.

5) decreases by a factor of 4.



$$X_L = \omega L$$

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