Lecture 42 outline: 12/02/2020

- Final homework due Friday afternoon.
- After today can do all problems except 10 and 13.
- Skip SPN 10-13 .. we'll talk SPN 10-10 on Friday.
- Faraday's law, problem SPN 10-11
- Self Inductance (problems 8/9)
- Mutual Inductance (problems 6, 7, 12)
- Boundary conditions at a current plane.

SPN 10-11

"A square loop of wire with sides "a" lies in x-y plane with one corner at the origin. $\vec{B} = k\,y^3\,t^2\,\hat{z}$. Find the EMF and the direction of induced current"

Capacitance | Resistance | Inductance

$$V_1 = \frac{Q_1}{C_1}$$

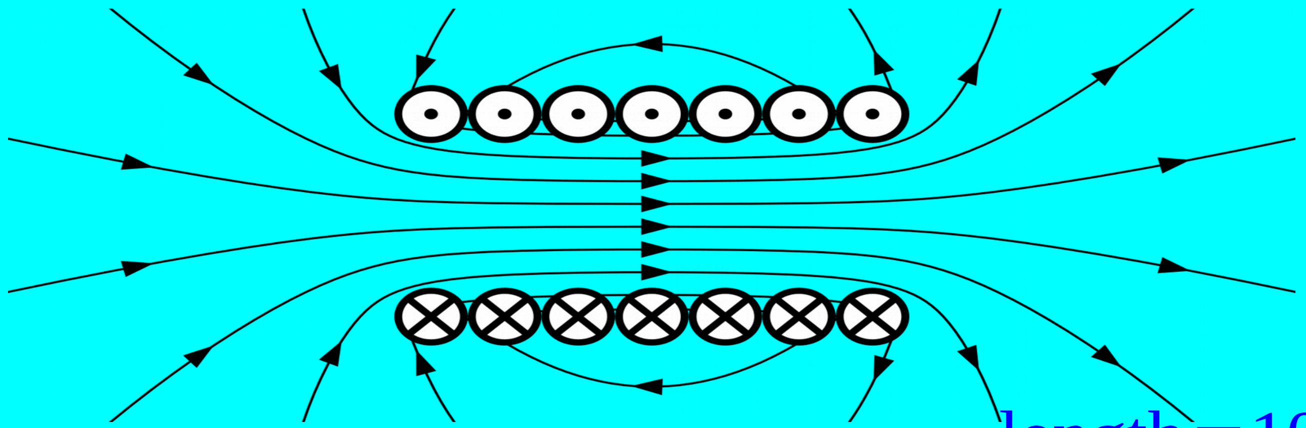
$$V_2 = \frac{Q_2}{C_{21}}$$

$$V = I R$$

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

$$\varepsilon_2 = -\frac{dI_1}{dt} M_{21}$$

Self Inductance of a solenoid (problem 8, 9):



$$\varepsilon = -\frac{\partial \Phi_B}{\partial t}$$

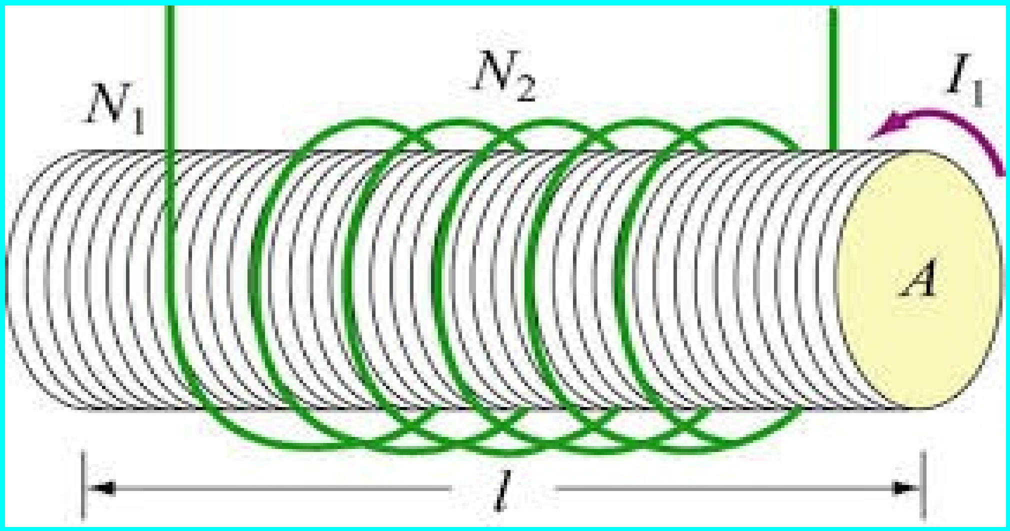
$$\varepsilon = -L\frac{dI}{dt}$$

$length = 10\,cm,\ N = 2900,\ d = 3\,cm$

Assume $V(t) = V_0 \cos(\omega t).\ f = 500\,Hz.$

Find I.

Mutual Inductance of two solenoids: (SPN 6, 7)



Mutual Inductance (HW #12)

A little loop of radius a is above a big loop of radius b. Show that the mutual inductances are equal.

$$\Phi_{B_2} = M_{21} I_1$$

$$\Phi_{B_1} = M_{12} I_2$$

$$M_{12} = M_{21}$$

Faraday's Law

$$\varepsilon = -\frac{\partial \Phi_B}{\partial t}$$

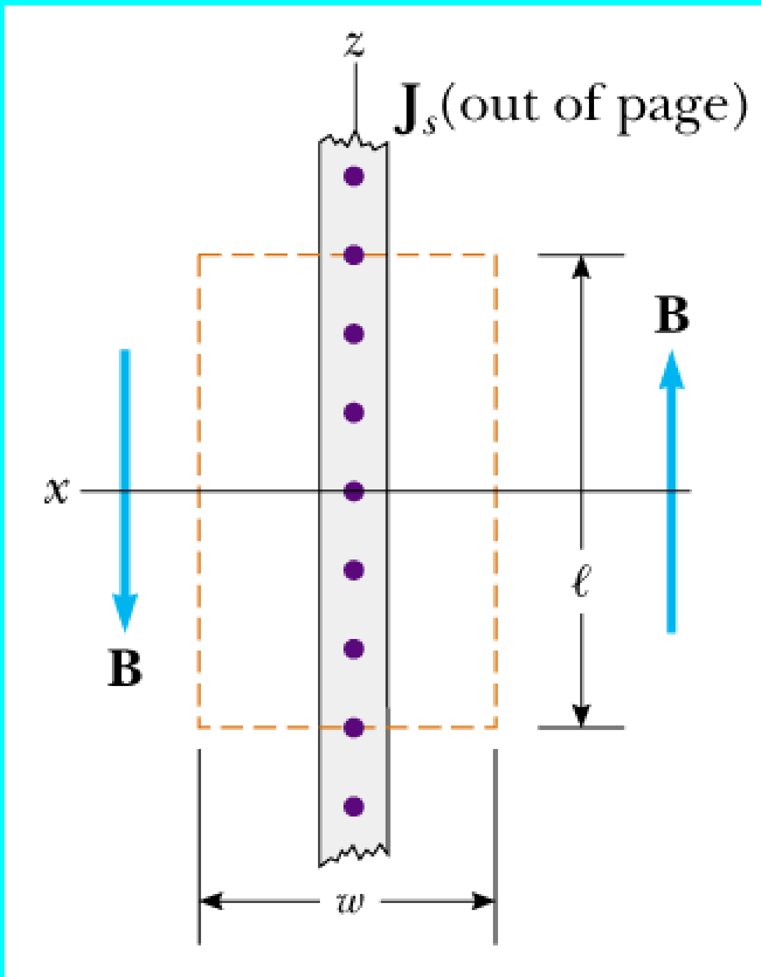
$$\oint \vec{E} \cdot d\vec{l} = -\frac{\partial \Phi_B}{\partial t}$$

$$\varepsilon = -\frac{\partial}{\partial t} \int \vec{B} \cdot d\vec{a}$$

$$\oint \vec{E} \cdot d\vec{l} = -\frac{\partial}{\partial t} \int \vec{B} \cdot d\vec{a}$$

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

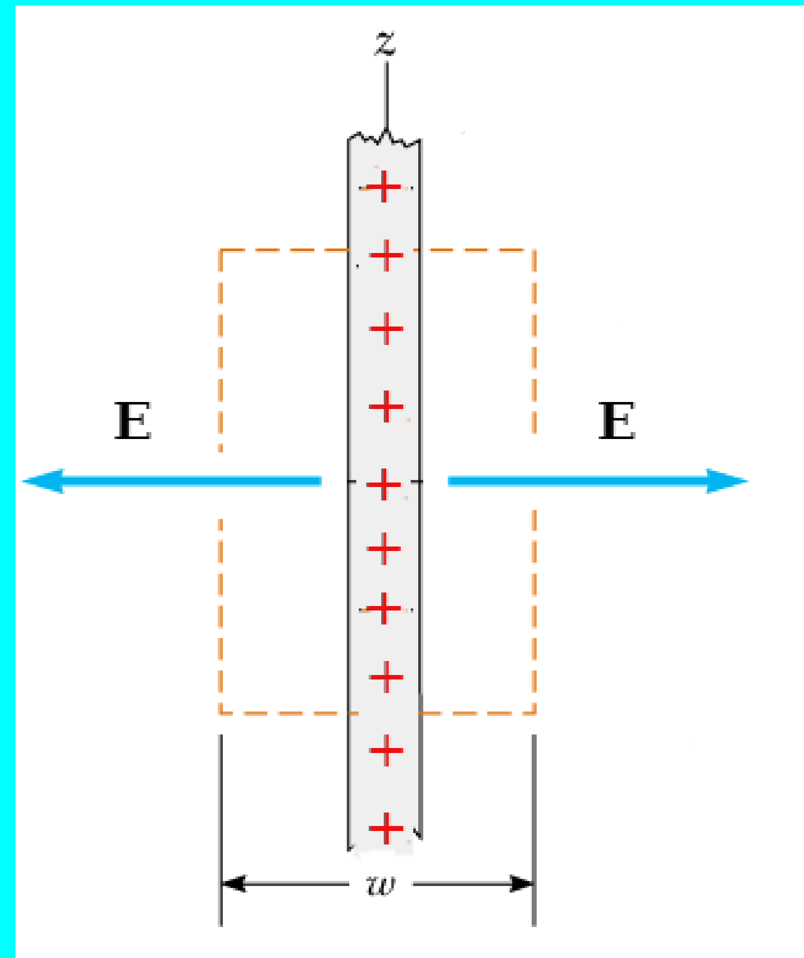
Infinite Current Sheet



$$\Delta B_{\parallel} = \mu_0 J t$$

$$\Delta B_{\parallel} = \mu_0 K$$

Infinite Charge Sheet



$$\Delta E_n = \frac{\sigma}{\epsilon_0}$$

Ampere's Law

(with displacement current)

$$\oint \vec{B}\cdot d\vec{l} = \mu_0 \epsilon_0 \frac{\partial}{\partial t}\Phi_E$$

$$\oint \vec{B}\cdot d\vec{l} = \mu_0 \epsilon_0 \frac{\partial}{\partial t}\int \vec{E}\cdot d\vec{a}$$

$$\int \nabla\times\vec{B}\cdot d\vec{a} = \mu_0 \epsilon_0 \frac{\partial}{\partial t}\int \vec{E}\cdot d\vec{a}$$

$$\nabla\times\vec{B} = \mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t}$$

Faraday's Law

$$\oint \vec{E}\cdot d\vec{l} = -\frac{\partial}{\partial t}\Phi_B$$

$$\oint \vec{E}\cdot d\vec{l} = -\frac{\partial}{\partial t}\int \vec{B}\cdot d\vec{a}$$

$$\int \nabla\times\vec{E}\cdot d\vec{a} = -\frac{\partial}{\partial t}\int \vec{B}\cdot d\vec{a}$$

$$\nabla\times\vec{E} = -\frac{\partial \vec{B}}{\partial t}$$