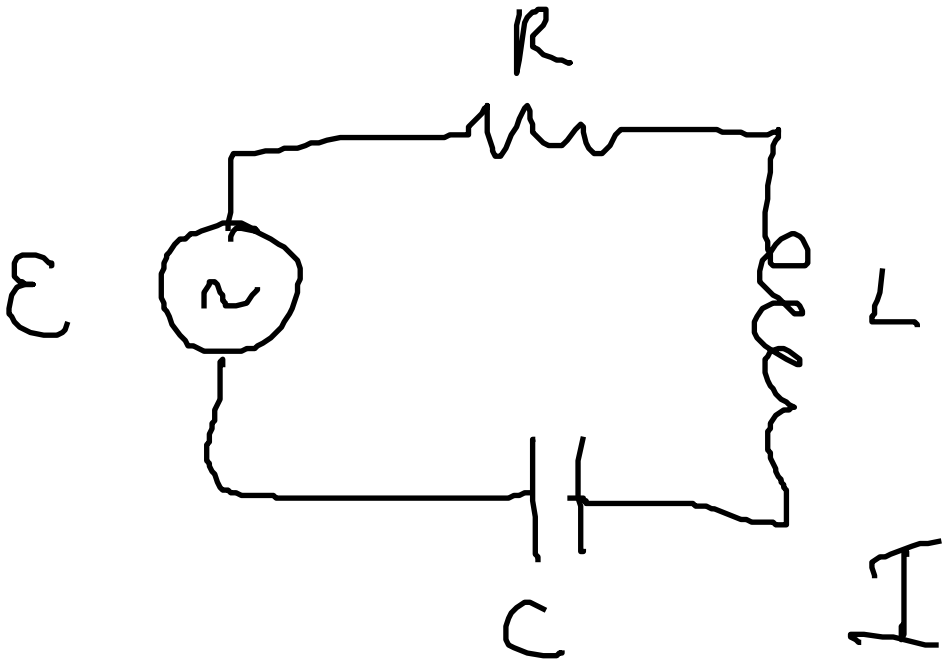


$$\mathcal{E} = \mathcal{E}_0 \cos(\omega t - \phi_0)$$

$$\mathcal{E}_0 \cos(\omega(t - t_0))$$

$$I = I_0 \cos \omega t$$

$$\mathcal{E}_0 = I_0 Z \quad \leftarrow \text{impedance}$$

$$\mathcal{E}_{rms} = I_{rms} Z$$

$$Z = \sqrt{R^2 + (X_C - X_L)^2}$$

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

inductive reactance $X_L = \omega L$

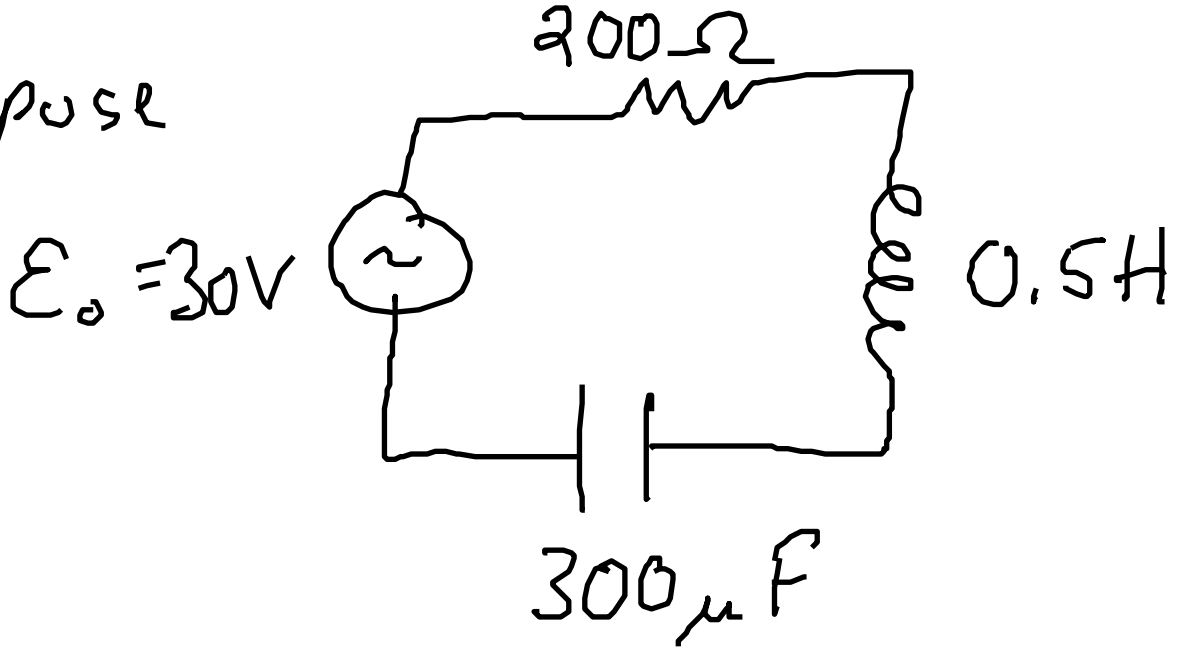
resonant angular frequency (max current) $X_C = X_L$

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$$\phi_0 = \tan^{-1} \frac{X_C - X_L}{R}$$

$$f_0 = \frac{\omega_0}{2\pi}$$

Suppose



- What is resonant angular frequency?

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(0.5H)(300\times10^{-6}F)}} = 81.6\ \frac{rad}{s}$$

$$f_0 = \frac{\omega_0}{2\pi} = 13Hz$$

- What is I_0 at this frequency?

$$I_0 = \frac{\mathcal{E}_0}{Z} \qquad Z = \sqrt{(200\Omega)^2 + (40.8-40.8)^2}$$

$$X_C = \frac{1}{\omega C} = \frac{1}{(81.6)(300\times10^{-6})} = 40.8\Omega$$

$$X_L = (81.6)(0.5H) = 40.8\Omega$$

$$Z = \sqrt{(200\Omega)^2} = 200\Omega \qquad I_0 = \frac{30V}{200\Omega} = 0.15A$$

What if $f = 60\ Hz$?

What is I_0 then?

$$\omega = 2\pi f = 377\ rad/s$$

$$X_C = \frac{1}{(377)(300\times10^{-6})} \qquad X_L = (377)(0.5)$$

$$= 8.8\ \Omega \qquad X_L = 188\ \Omega$$

$$Z = \sqrt{(200)^2 + (8.8-188)^2}$$

$$= 269\ \Omega$$

$$I_0 = \frac{30\ V}{269\ \Omega} = 0.11\ A$$

AC Current in Practice

$$P_{avg} = I_{rms} V_{rms}$$

In everyday use we want V_{rms} to be relatively small for safety

low V? high I.

In transmission lines

$$P_{loss} = I_{rms}^2 R$$

e.g. 500MW = $P_{carried}$

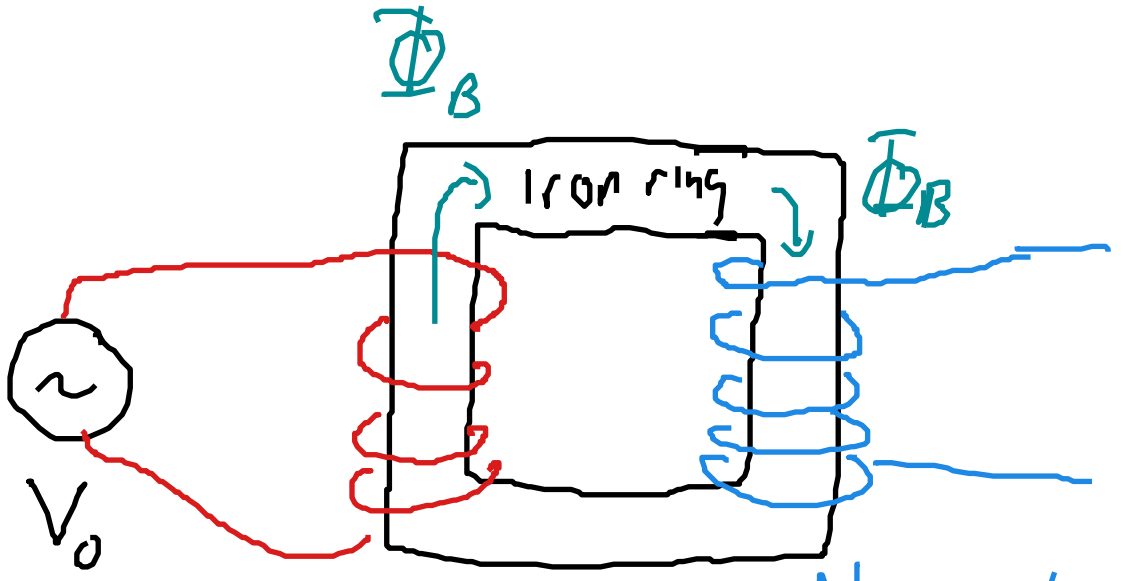
transmitted at 350 kV

$$I = \frac{500MW}{350kV} = 1.43kA$$

if wire is $R = 50\Omega$, $P_{loss} = I^2R = 102MW$

20% loss

Transformer



$$V_p = N_p \frac{d\Phi_B}{dt} \qquad V_s = N_s \frac{d\Phi_B}{dt}$$

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

if $N_s > N_p$, $V_s > V_p$

"step-up transformer"

if $N_s < N_p$, $V_s < V_p$

"step-down transformer"

END OF

EXAM 3

MATERIAL