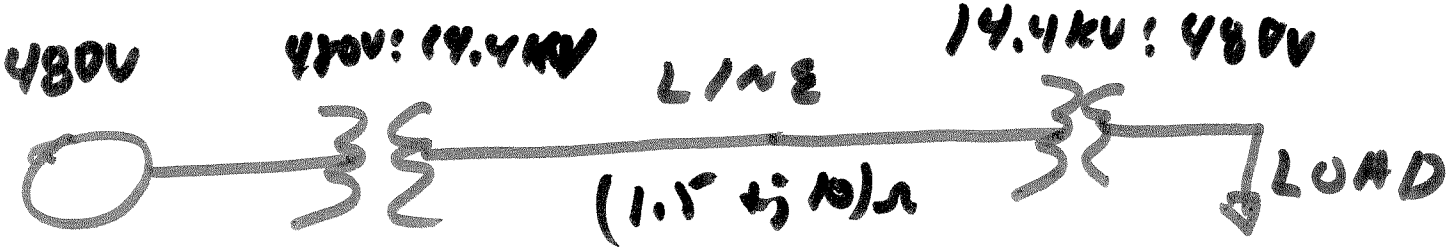
ECE 320 & ECE 329

ENERGY SYSTEMS I
BACKGROUND STUDY IN ENERGY SYSTEMS

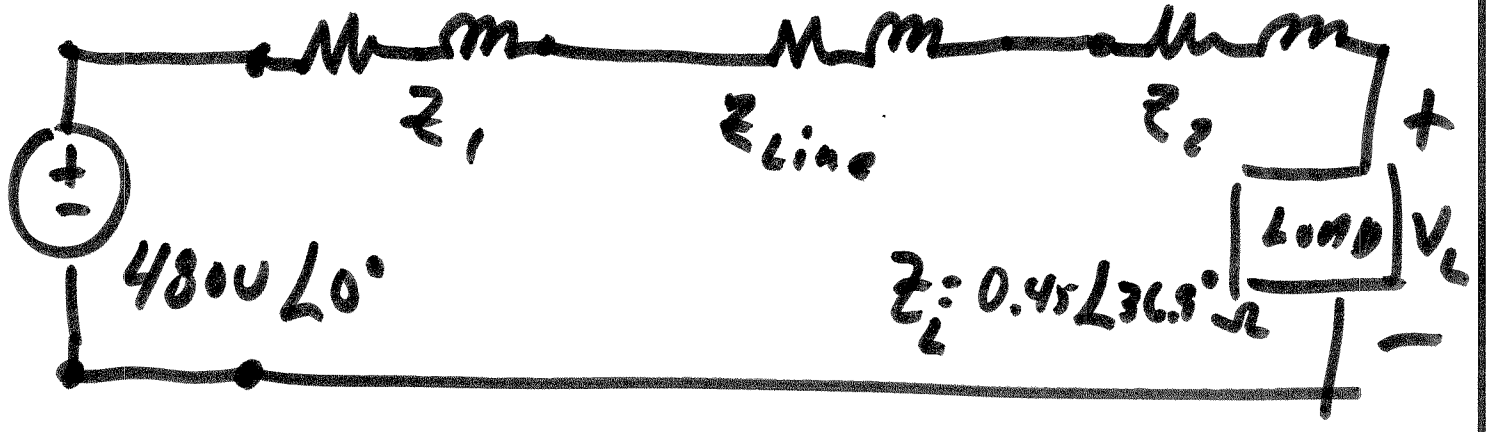
SESSION no. 10



$Z_1 = (0.00238 + j\,0.00952)\,\Omega$

$Z_2 = (0.00476 + j\,0.\blacksquare 0203)\,\Omega$

FIND EFFICIENCY.



$$Z_{Line} = \frac{(0.5 + j10)\Omega}{\left(\frac{14400\,V}{480\,V}\right)^2}$$

$$Z_{Line} = (1.67 \times 10^{-3} + j0.011)\,\Omega$$

$$V_L = 480\,V\angle 0^\circ \left[\frac{0.45^\circ \angle 36.9^\circ\,\Omega}{Z_1 + Z_{Line} + Z_2 + Z_L}\right]$$

$$V_L = (447.1 - j25.4)\,V$$

$$P_{out} = \mathrm{Re}\left[\frac{|V_L|^2}{(0.45^\circ \angle 36.9^\circ)^*}\right] = \underline{\underline{356.4\ W}}$$

$$P_{in} = Re\left[V_s \quad I^*\right]$$

$$V_s = 480\angle 0^\circ \text{ V}$$

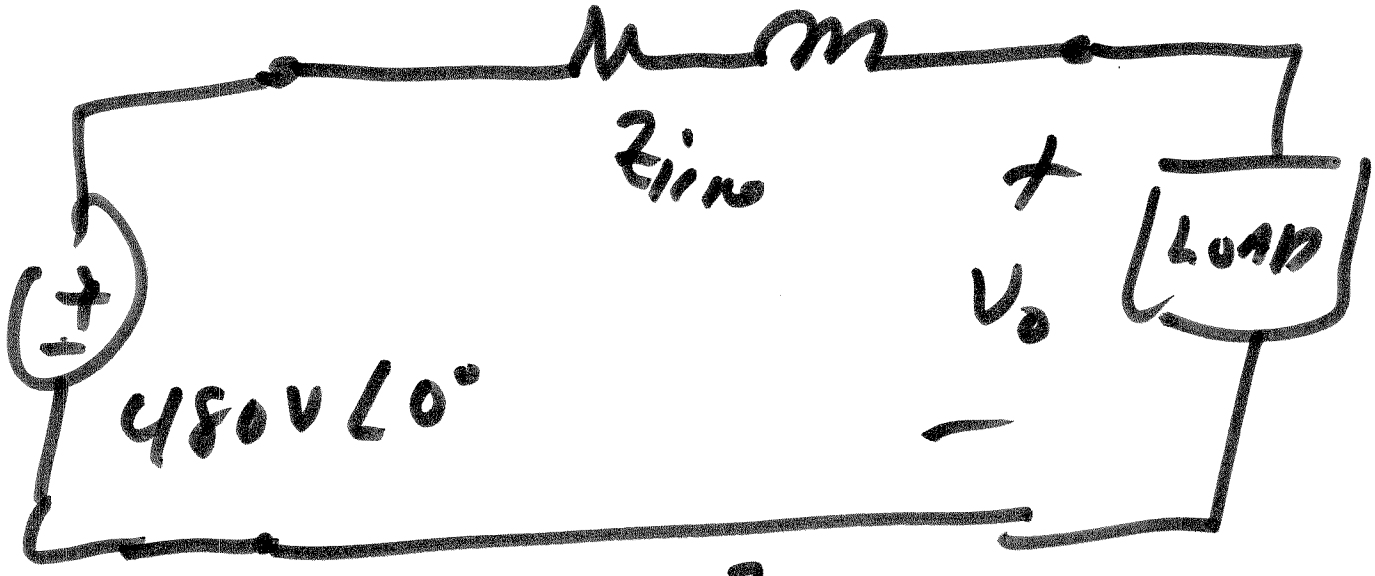
$$I = \frac{480\angle 0^\circ \text{ V}}{Z_1 + Z_{Lin} + Z_2 + Z_L} = (760.6 - j641.7)\text{ A}$$

$$P_{in} = Re\left[(480\angle 0^\circ)(760.6 + j641.7)\right]$$

$$P_{in} = 365.1 \text{ W}$$

$$\eta = \frac{P_{out}}{P_{in}} = \frac{376.4 \text{ W}}{365.1 \text{ W}} = \underline{\underline{0.976}}$$

W/O TRANSFORMERS



$$V_0 = V_s \cdot \frac{Z_L}{Z_L + Z_{line}} = (115.2 - j14.1)\ V$$

$$P_1 = R_e\left(\frac{|V_0|^2}{Z_L^*}\right) = \underline{761.1\ W}$$

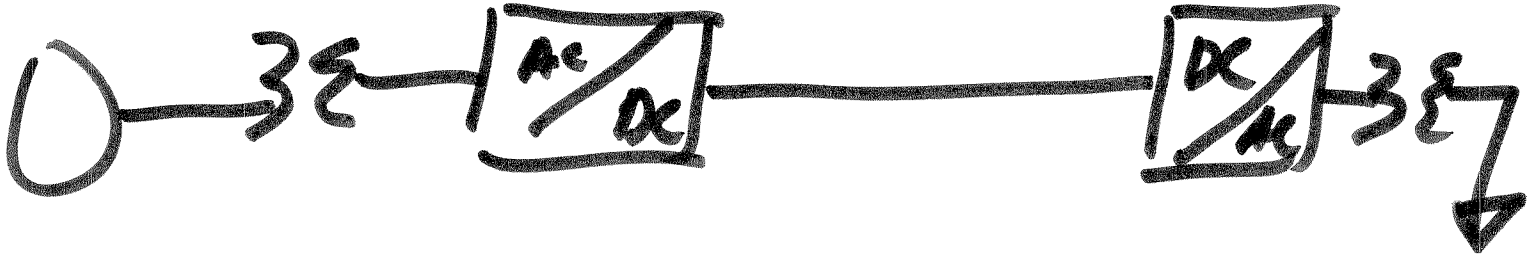
$$P_{in} = R[V_s I^*]$$

$$I^* = \frac{V_L}{Z_L} = (8.2 - j\,45.3)\,A$$

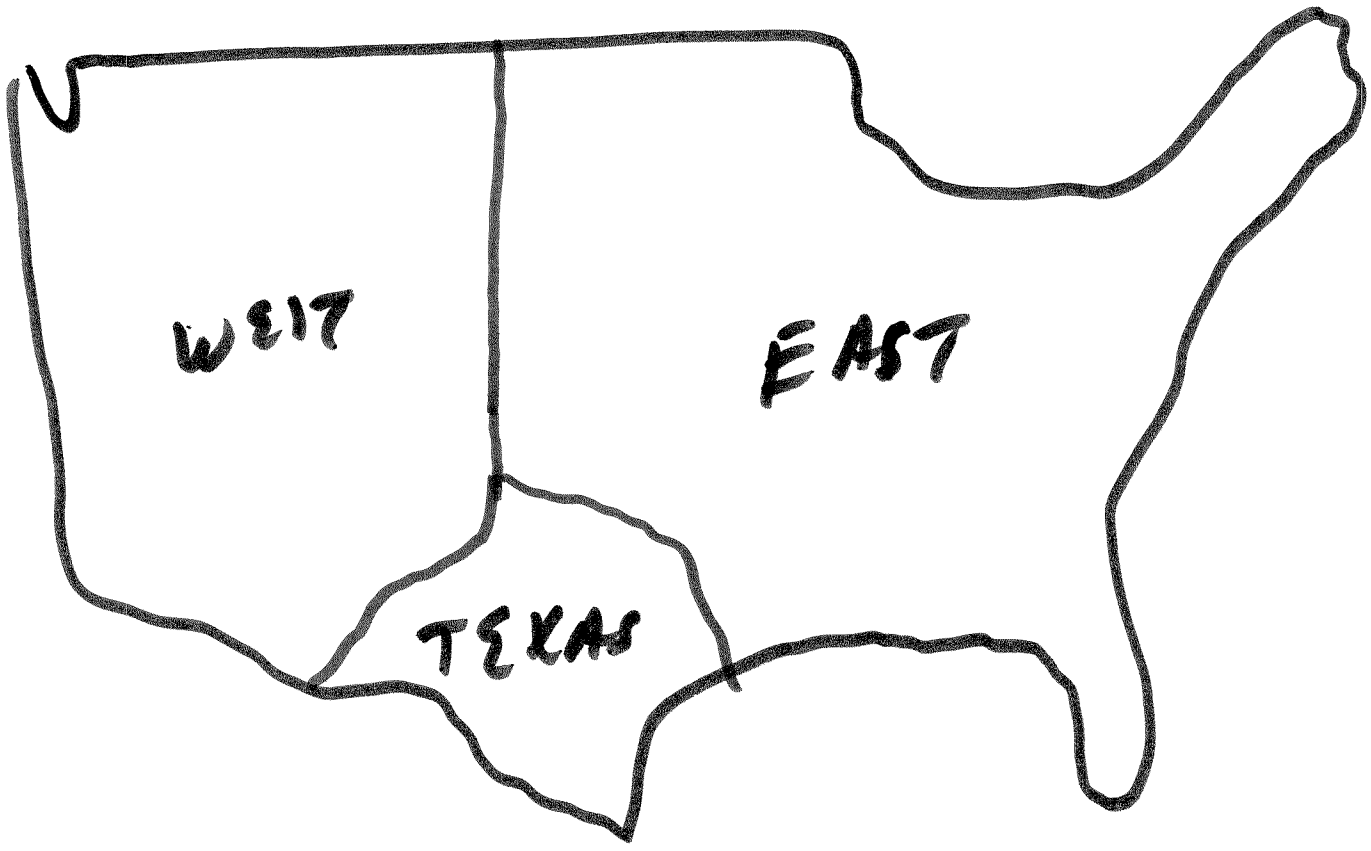
$$P_{in} = R[(490\angle 0°\,V)(8.2 + j\,45.3)A]$$

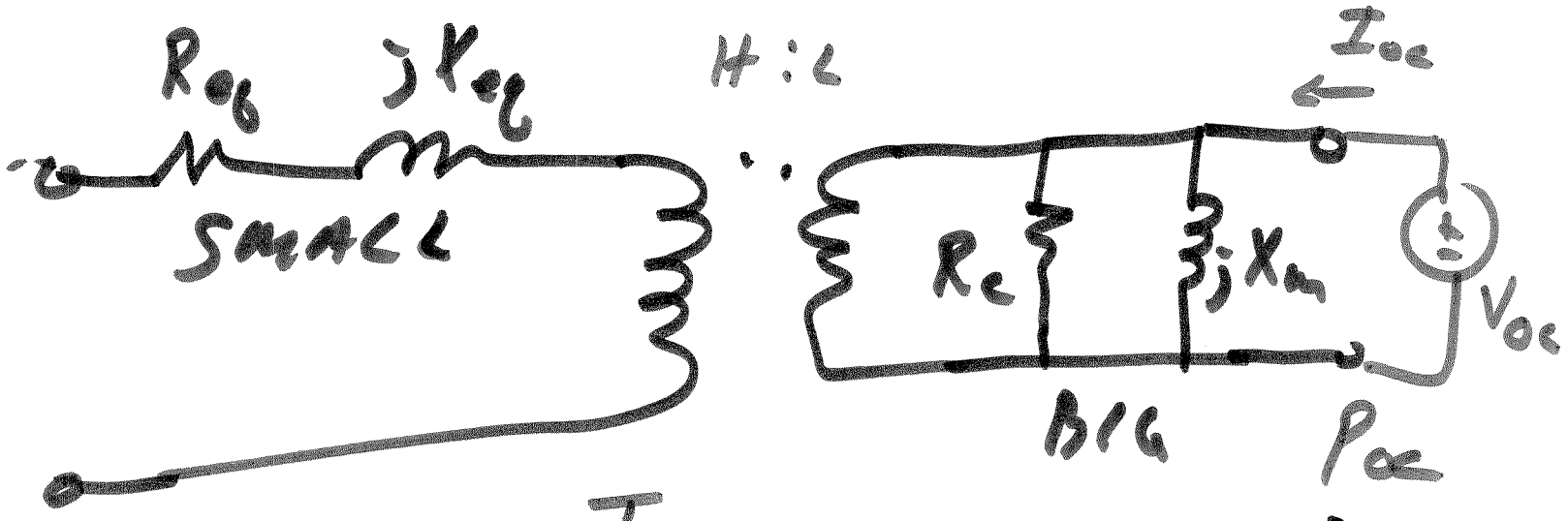
$$P_{in} = 3.93\,kW$$

$$\eta = \frac{P_o}{P_{in}} = \frac{761.1\,W}{3930\,W} = \underline{\underline{0.193}}$$


AC
DC
DC
AC

University of Idaho



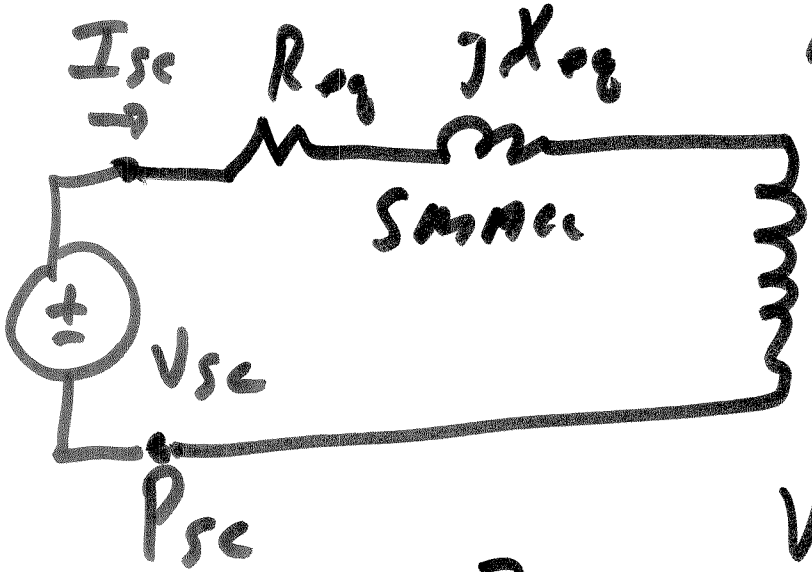


P_{oc}

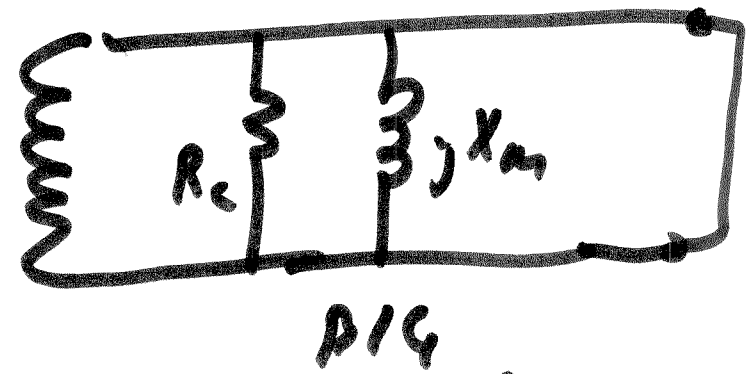
ADMITTANCE $Y_{oc} = \dfrac{I_{oc}}{V_{oc}}$

CONDUCTANCE $G_{oc} = \dfrac{P_{oc}}{|V_{oc}|^2}$

SUSCEPTANCE $B_{oc} = \sqrt{Y_{oc}^2 - G_{oc}^2}$



H:C



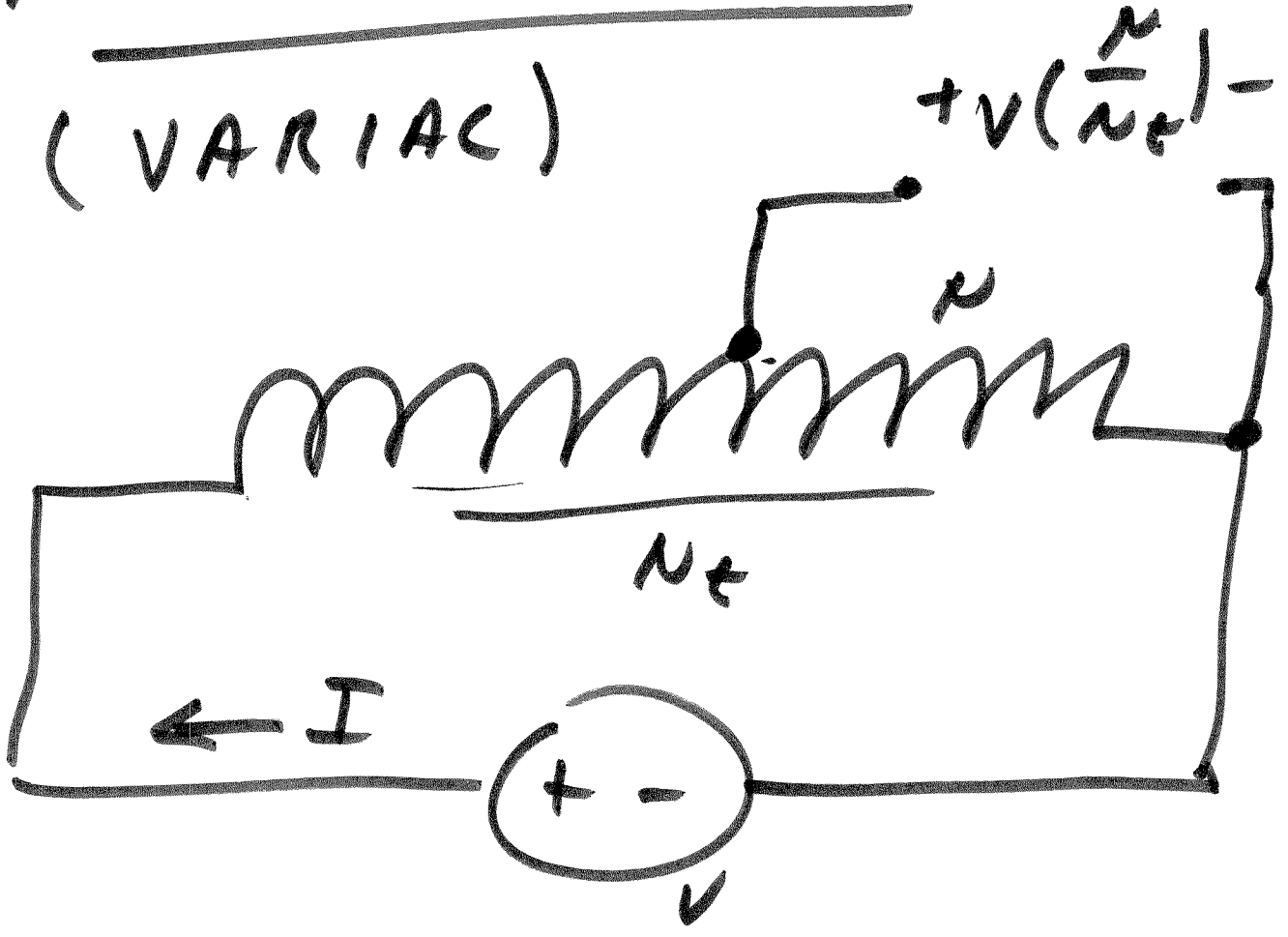
$$Z_{sc} = \frac{V_{sc}}{I_{sc}} =$$

$$R_{sc} = \frac{P_{sc}}{|I_{sc}|^2} = R_{eq}$$

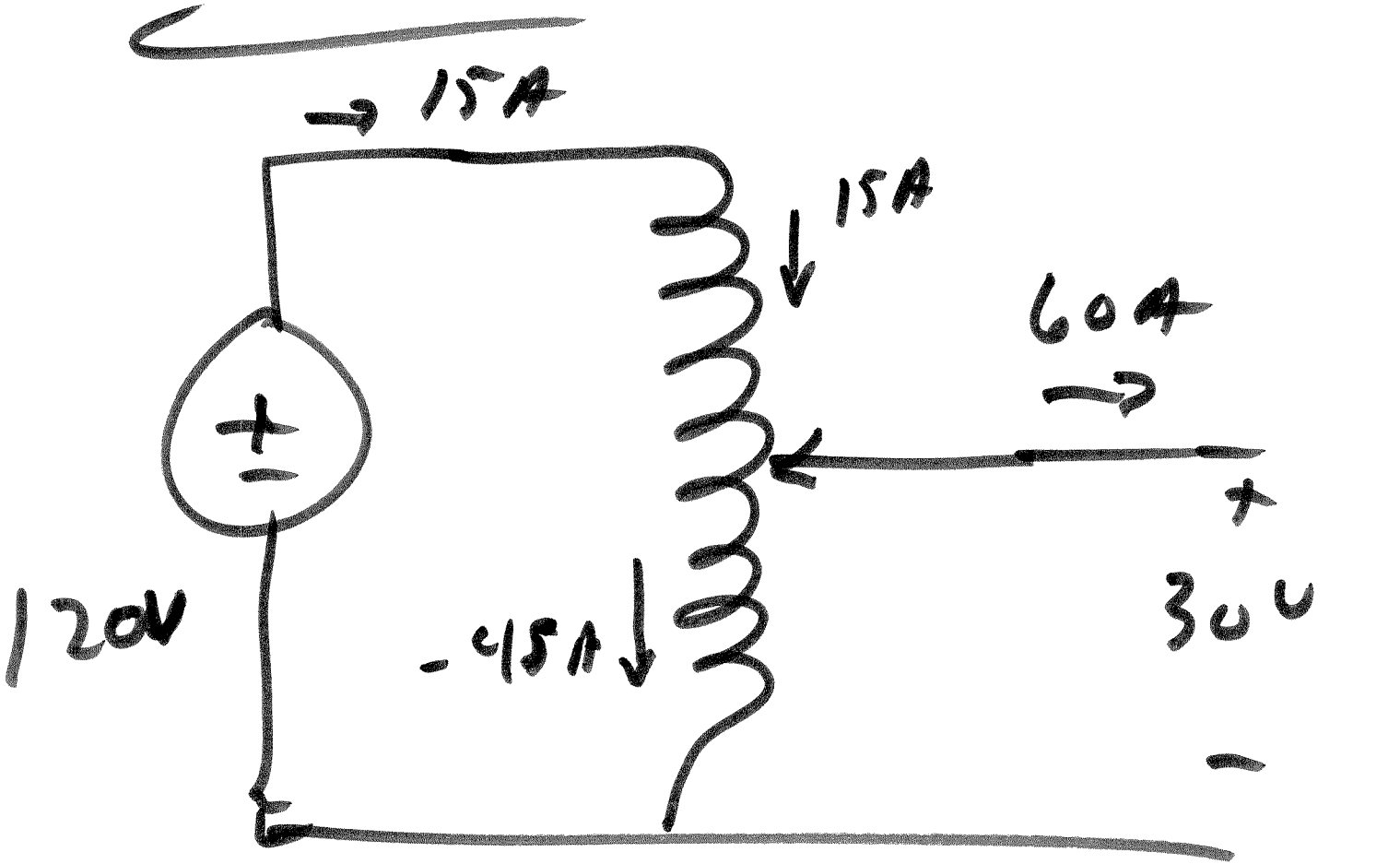
$$X_{sc} = \sqrt{Z_{sc}^2 - R_{sc}^2} = X_{eq}$$

AUTO TRANSFORMER

(VARIAC)



EXAMPLE



15π

$\frac{15}{4} = 3.75\pi$

-45π

ECE 320

Energy Systems I

Lesson 10

Transformers

☺ Variable transformer

☺ Works like a voltage divider

☺ Wind only one coil

☹ Mechanical size scale

☹ No isolation