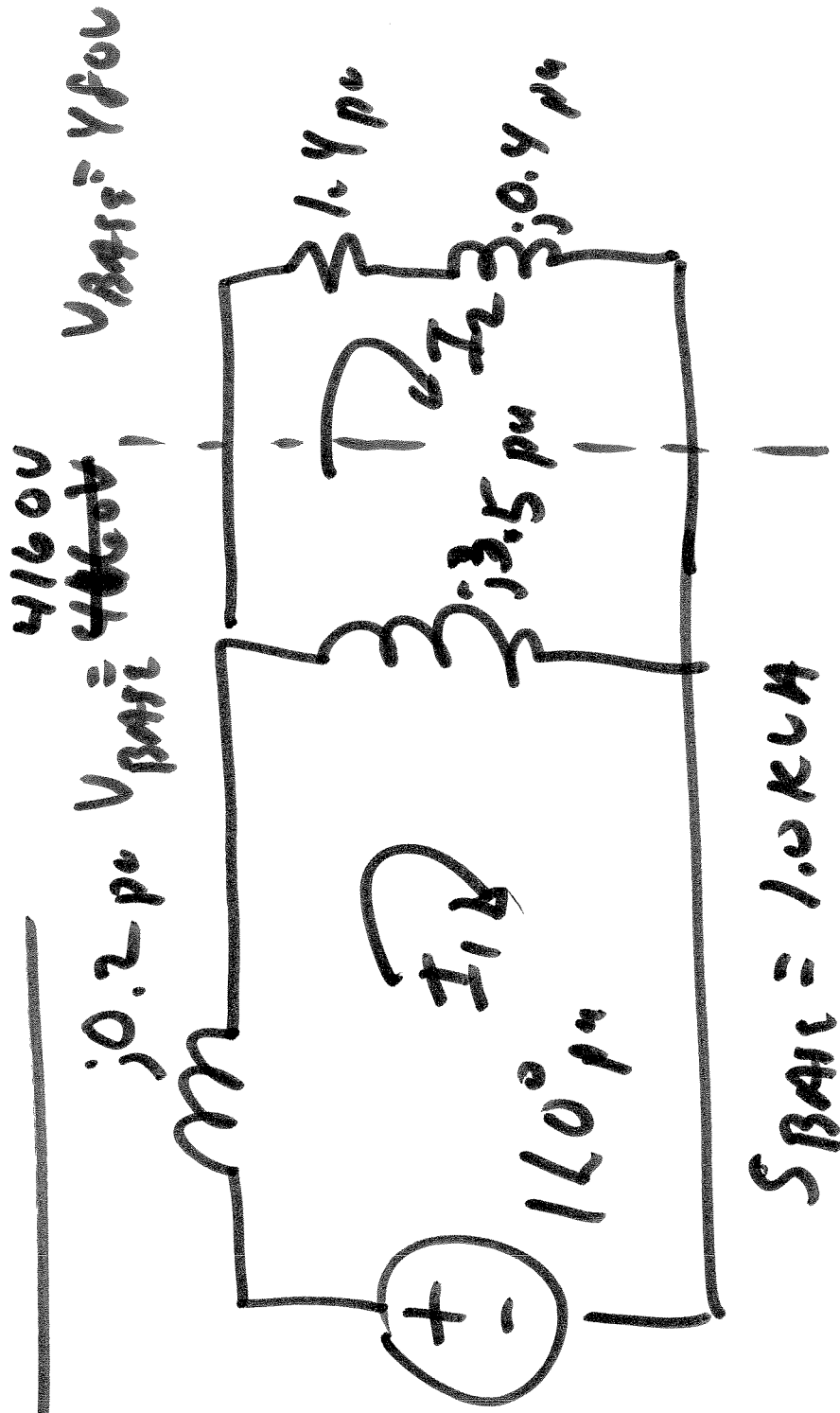


ECE 320 & ECE 329

ENERGY SYSTEMS I  
BACKGROUND STUDY IN ENERGY SYSTEMS

SESSION no. 15

# PER UNIT



FIND INPUT POWER

$$\begin{bmatrix} j3.7 & -j3.5 \\ -j3.5 & (1.4 + j3.9) \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 110 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 0.543 - j0.499 \\ 0.574 - j0.242 \end{bmatrix}$$

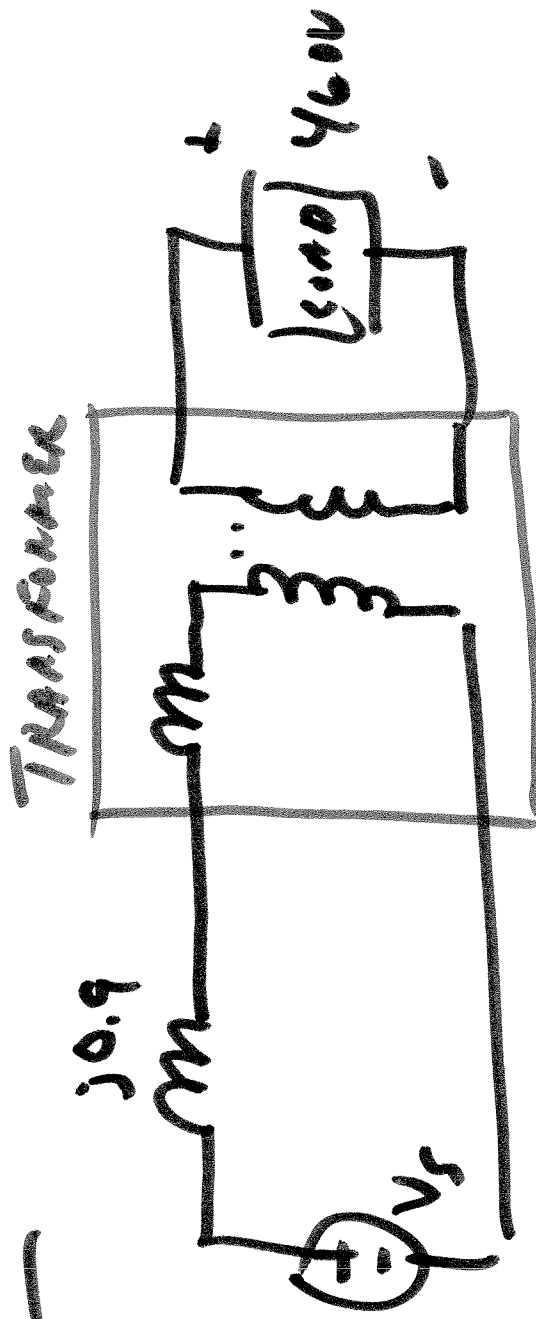
$$\begin{aligned} P_{in} &= \operatorname{Re}(V_{in} I_1^*) \\ &= \operatorname{Re}((110)(0.543 + j0.499)) \end{aligned}$$

$$\underline{P_{in} = 0.543 \text{ pu}}$$

$$P_{in} = (0.543) (1 \text{ kW})$$

$$P_{in} = \underline{\underline{543 \text{ WATTS}}}$$

# EXAMPLE



$$S_{BASE} = 10 \text{ MVA}$$

$$V_{BASE} = 13.2 \text{ kV} \quad V_{BASE} = 460 \text{ V}$$

- TRANSFORMER FAILS.
- PUT IN A NEW TRANSFORMER.
- FIND ANSC PER UNIT CIRCUIT.

$$\frac{13.8 \text{ kV}}{\text{"New" TRANSLFORMER}} \quad 12 \text{ MVA} \quad X = 8\%$$

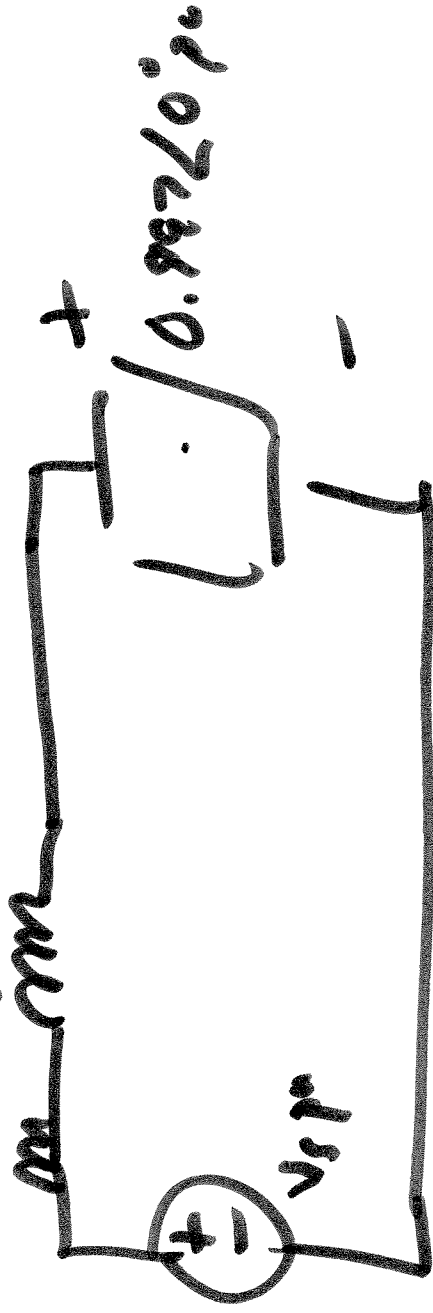
$$Z_{pu} = j0.08 \cdot \frac{Z_{BASE \text{ old}}}{Z_{BASE \text{ new system}}}$$

$$Z_{BASE \text{ old}} = \frac{(480 \text{ V})^2}{12 \text{ MVA}} = 0.0192 \Omega$$

$$Z_{BASE \text{ system}} = \frac{(460 \text{ V})^2}{10 \text{ MVA}} = 0.0212 \Omega$$

$$Z_{pu} = j0.08 \cdot \frac{0.0192}{0.0212} = \underline{\underline{j0.073 \text{ pu}}}$$

$$j0.1 \quad j0.073$$



$$V_{BASE} = 13.2 \mu V \quad ; \quad V_{BASE} = 459 \mu V$$

$$I_{BASE} = 10 \mu A \quad \uparrow$$

$$V_{BASE} = \frac{459 \mu V}{13.2 \mu V} \cdot 480 \mu V = 15.9 \mu V$$

ECE 320 / ECE 329

Energy Systems I

Lesson 15

Per unit

Exam #1

Topics

1. AC circuits
2. Transformers
3. AC power
4. Per unit

23 February Thursday

1800-2100

Two hour exam

McClure 214A

Open book, open notes, open computer

HW4 recitation is Friday (lesson 16)

Per unit

- a. Set up
- b. Analysis

Reason for changing base: we have a transformer that has a per unit impedance that is based on bases that aren't the same as our overall system bases.