E_E 491
Review Session #1

Ali Shakeri Kahnamouei

Fall 2020

$v = A\cos(\omega t + \varphi_1)$, $i = B\cos(\omega t + \varphi_2)$

Max values : A , B

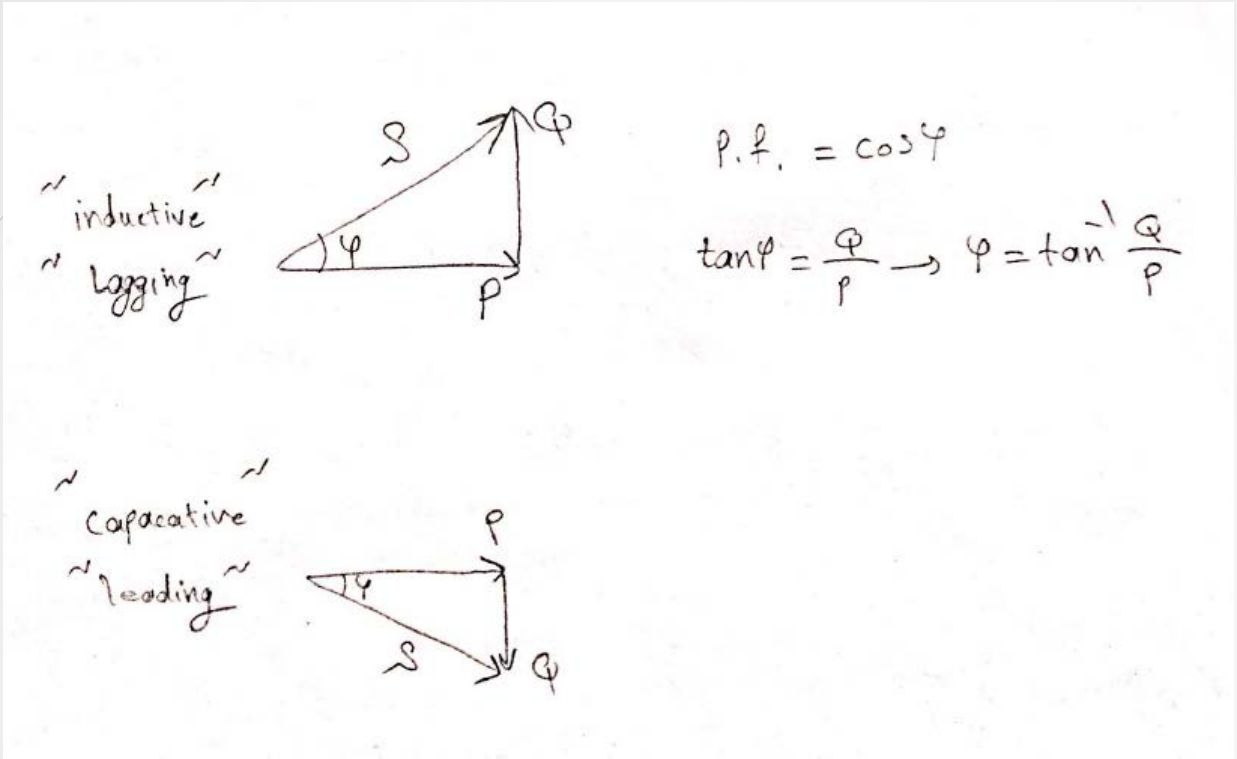
RMS values : $\frac{A}{\sqrt{2}}$, $\frac{B}{\sqrt{2}}$

$\dot{V} = \frac{A}{\sqrt{2}} \angle \varphi_1$, $\dot{I} = \frac{B}{\sqrt{2}} \angle \varphi_2 = \frac{B}{\sqrt{2}}(\cos\varphi_2 + j\sin\varphi_2)$

if v is reference :

$\dot{V} = \frac{A}{\sqrt{2}} \angle 0$, $\dot{I} = \frac{B}{\sqrt{2}} \angle(\varphi_2 - \varphi_1)$

Principles


inductive
Lagging
S
Q
φ
P
P.f. = cosφ
tanφ = Q/P → φ = tan⁻¹ Q/P
capacative
leading
P
φ
S
Q

Principles

Principles

$$P = R|I|^2 \quad , \quad Q = X|I|^2$$

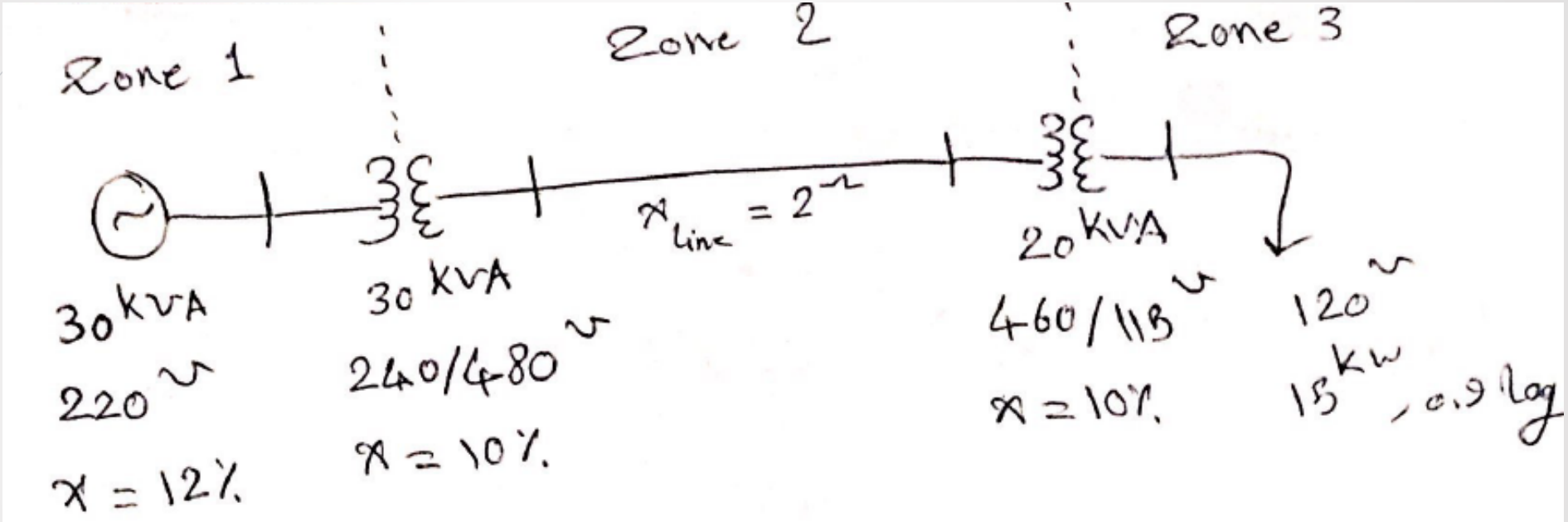
$$S = VI^*$$

if 3-phase: $P = \sqrt{3}|V||I|\cos\varphi$

$$Q = \sqrt{3}|V||I|\sin\varphi$$

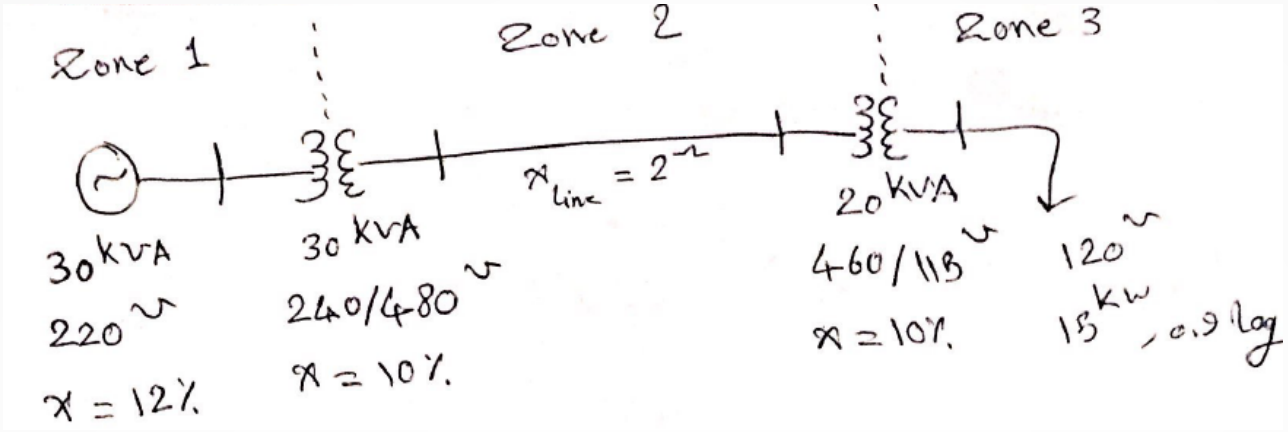
if 2 loads at the end:

$$S_t = S_1 + S_2 \Longrightarrow \text{P.f.}$$



Per Unit System

Example



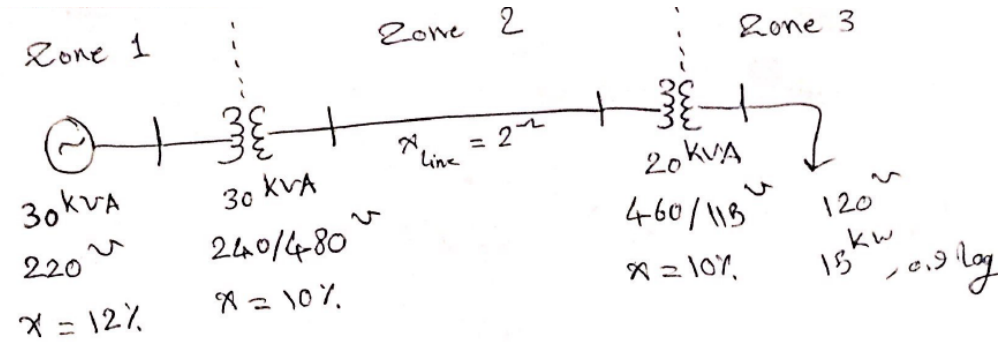
$$S_{base} = 30\ kVA$$

$$v_{base_1} = 220\ V \Rightarrow v_{base_2} = 220 \times \left(\frac{480}{240}\right) = 440\ V$$

$$\Rightarrow v_{base_3} = 440 \times \left(\frac{115}{460}\right) = 110\ V$$

Specify Base S and V

We know : $Z_{pu}^{new} = Z_{pu}^{old} \times \frac{S_{base}^{new}}{S_{base}^{old}} \times \left(\frac{V_{base}^{old}}{V_{base}^{new}} \right)^2$



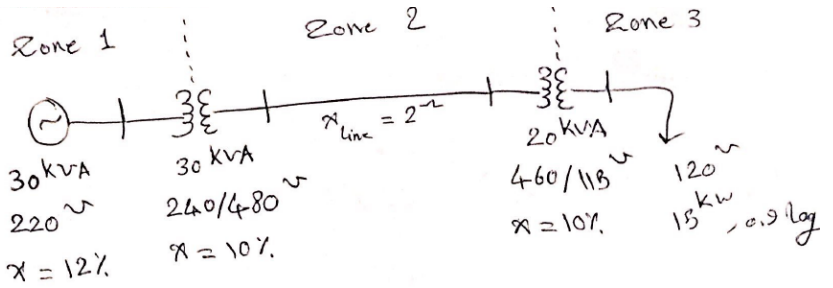
$$X_G = 0.12^{pu} \quad \text{(no change)}$$

$$X_{T_1} = 0.1 \times \frac{30^{kVA}}{30^{kVA}} \times \left(\frac{240}{220}\right)^2 = 0.1190^{pu}$$

$$Z_{base_{Line}} = \frac{V^2_{base_{Line}}}{S_{base}} = \frac{(440)^2}{30^{kVA}} = 6.4533^{\Omega}$$

$$X_{Line} = \frac{2}{6.4533} = 0.3099^{pu}$$

$$X_{T_2} = 0.1 \times \frac{30^{kVA}}{20^{kVA}} \times \left(\frac{115^{V}}{110^{V}}\right)^2 = 0.1640^{pu}$$

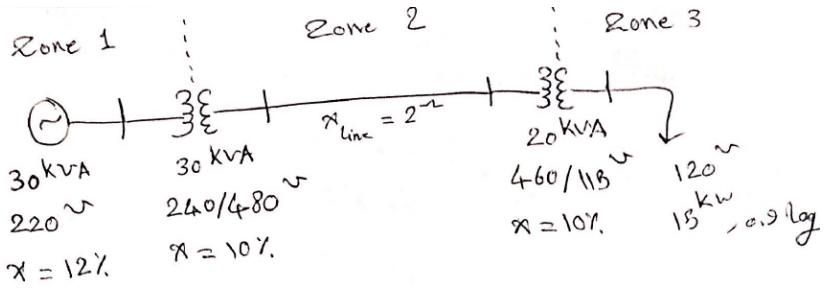


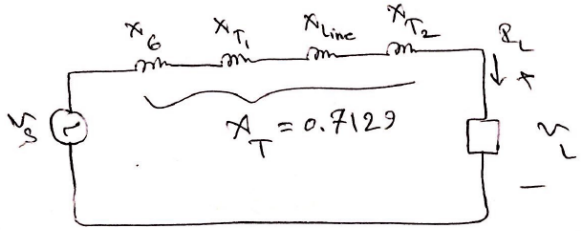
$$|\tilde{V}_L| = \frac{120^{\sim}}{110^{\sim}} = 1.0909\ pu$$

$$P_L = \frac{15\ kw}{30} = 0.5\ pu = |\tilde{V}_L||\tilde{I}_L|\cos\theta$$

$$\Rightarrow |\tilde{I}_L| = \frac{0.5}{1.0909 \times 0.9} = 0.5093\ pu$$

$$\tilde{V}_L = 1.0909 \angle 0 \quad , \quad \tilde{I}_L = 0.5093 \angle -\cos^{-1}(0.9)$$



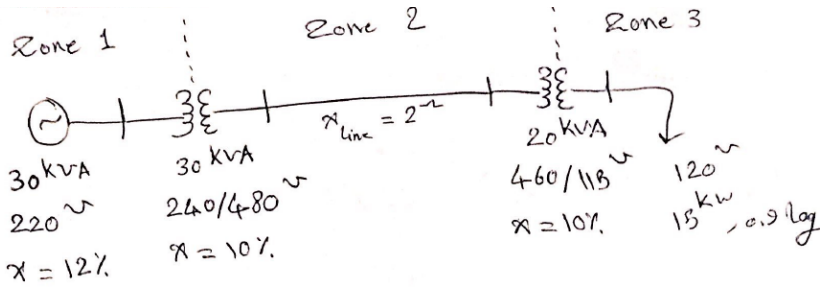


$$V_S = V_L + jX_T \times I_L$$

$$= 1.0909 + (0.7129\angle 90^\circ)(0.5093\angle -\cos^{-1}(0.9))$$

$$= 1.2492 + j0.3268 = 1.2912\angle 14.66^\circ$$

$$|V_S| = 1.2912 \times 220^{V} = 284^{V}$$



Questions?