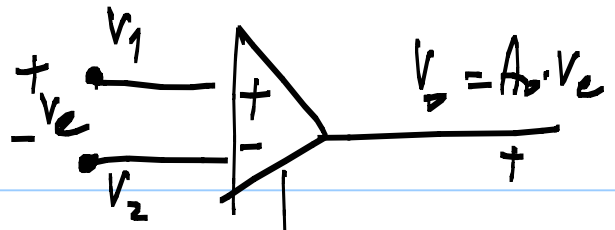
EC1010 : Lecture 40

1.001 V 1mV
1 V 0



$\bar{V}_s = [\Lambda]^{-1} \bar{V}$ ← Unbalanced

$\bar{V} = [\Lambda] \bar{V}_s$

0, +ve & −ve seq.

$V_b = A_d \cdot V_e + A_{cm}\left(\frac{V_1 + V_2}{2}\right)$

$V_b = \alpha_1 V_1 + \alpha_2 V_2$

$\alpha_2 = -\alpha_1$

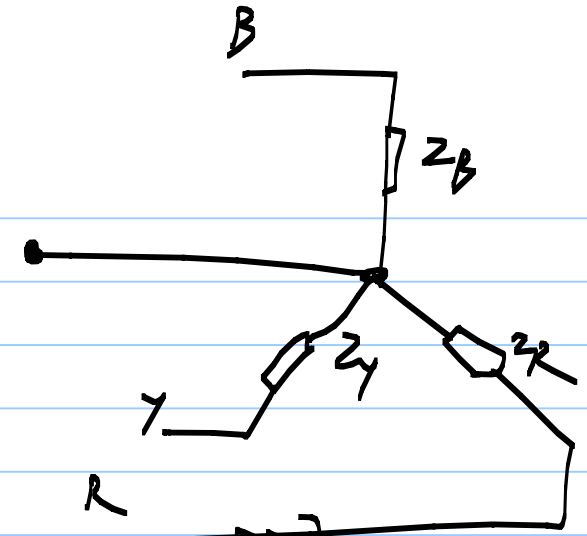
$\begin{bmatrix} \bar{I}_R \\ \bar{I}_Y \\ \bar{I}_B \end{bmatrix}$

* Motor: −ve seq. current ⇒ negative torque

* 4-wire load: Zero seq current ⇒ neutral wire current

$$\bar{V} = [Z] \cdot \bar{I}$$

$$[Z] = \begin{bmatrix} Z_R & 0 & 0 \\ 0 & Z_Y & 0 \\ 0 & 0 & Z_B \end{bmatrix}$$



$$[\Lambda]\,\bar{V}_S = [Z][\Lambda]\,\bar{I}_S$$

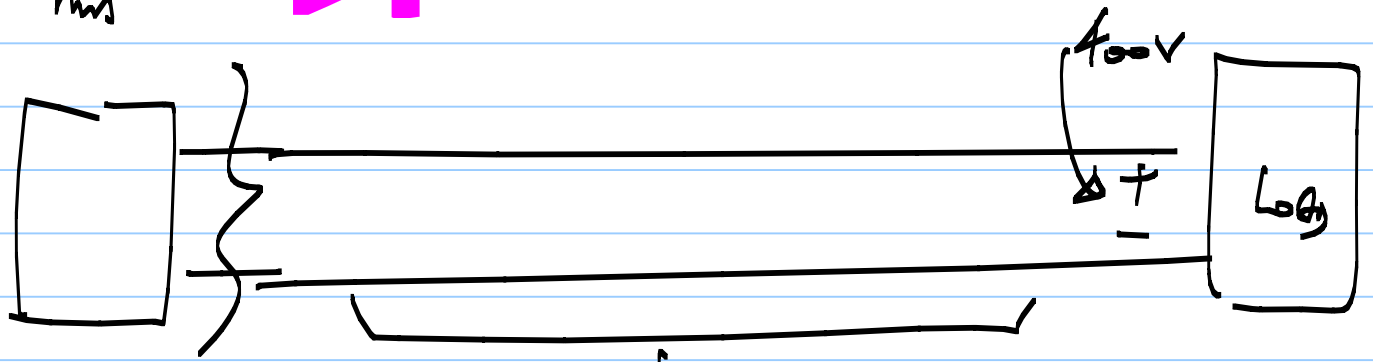
$$\bar{V}_S = \left\{ [\Lambda]^{-1}[Z][\Lambda] \right\} \bar{I}_S$$

$$\begin{bmatrix} I_0 \\ I_1 \\ I_2 \end{bmatrix} \bar{I}_S = [\Lambda]^{-1} \begin{bmatrix} \bar{I}_R \\ \bar{I}_Y \\ \bar{I}_B \end{bmatrix}$$

$$\frac{1}{3} \quad \frac{1}{3} \quad \frac{1}{3}$$

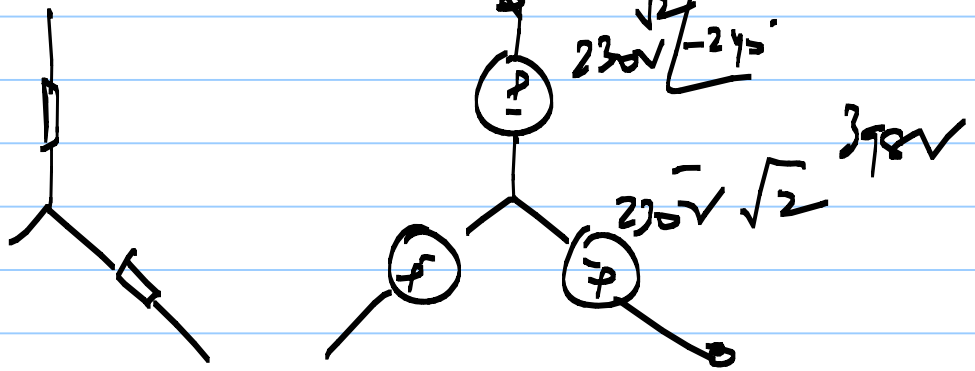
230Vrm → 400V line-line $230\sqrt{3} = 398V$

$230V_{rms}$ → 400V

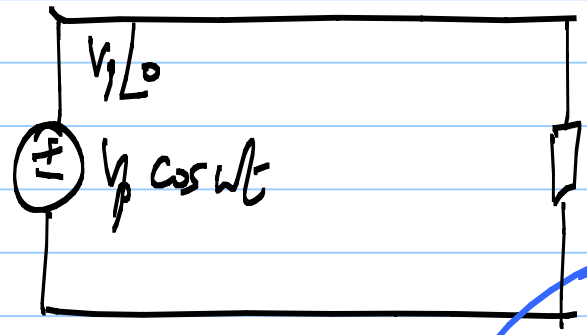


11kV/440V 440V

$V_p \angle \phi$



AC power + measurement



$$p(t) = \frac{V_p I_p}{2} \cos\phi + \frac{V_p I_p}{2} \cos(2\omega t + \phi)$$

$$\bar{p} = \frac{V_p \cdot I_p^*}{2} = \frac{V_p I_p}{2} \cos\phi - j \frac{V_p I_p}{2} \sin\phi$$

$$\frac{V_p I_p}{2} \cos\phi + \frac{V_p I_p}{2} \cos(2\omega t) \cos\phi - \left(\frac{V_p I_p}{2}\right) \sin(2\omega t) \sin\phi$$

avg

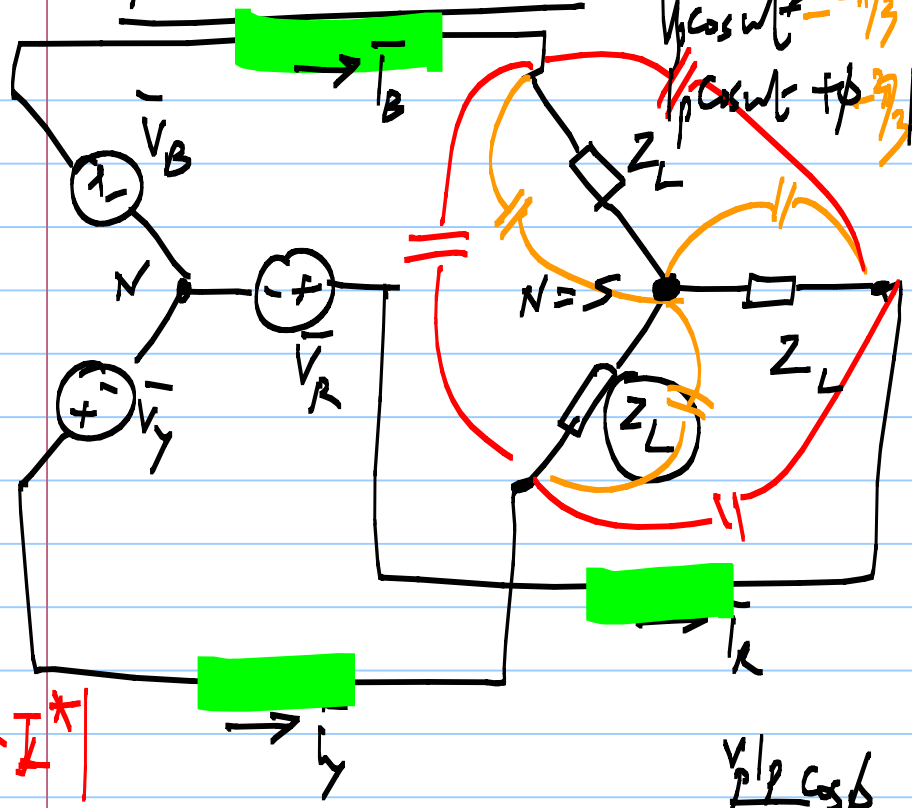
$P_{av} = Re[\bar{p}]$

reactive power

apparent power

$$pf = \frac{Re[\bar{p}]}{|\bar{p}|}$$

3 phase balanced case:



$\bar{V}_R = V_p \angle 0 \quad ; \quad \bar{I} = I_p \angle \phi$

$V_p \cos \omega t \quad V_p \cos(\omega t - 2\pi/3) \quad V_p \cos(\omega t + 2\pi/3)$

$$p(t) = \frac{V_p I_p}{2}\cos\phi + \frac{V_p I_p}{2}\cos(2\omega t)\cos\phi - \frac{V_p I_p}{2}\sin(2\omega t)\sin\phi$$

$$+ \frac{V_p I_p}{2}\cos\phi + \frac{V_p I_p}{2}\cos\left(2\omega t - \frac{4\pi}{3}\right)\cos\phi - \frac{V_p I_p}{2}\sin\left(2\omega t - \frac{4\pi}{3}\right)\sin\phi$$

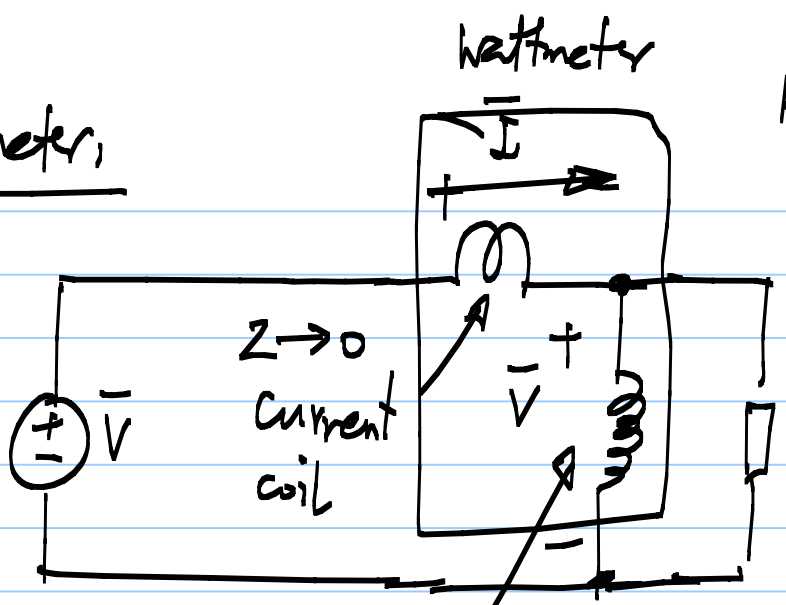
$$+ \frac{V_p I_p}{2}\cos\phi + \frac{V_p I_p}{2}\cos\left(2\omega t + \frac{4\pi}{3}\right)\cos\phi - \frac{V_p I_p}{2}\sin\left(2\omega t + \frac{4\pi}{3}\right)\sin\phi$$

$|V \cdot I^*|$

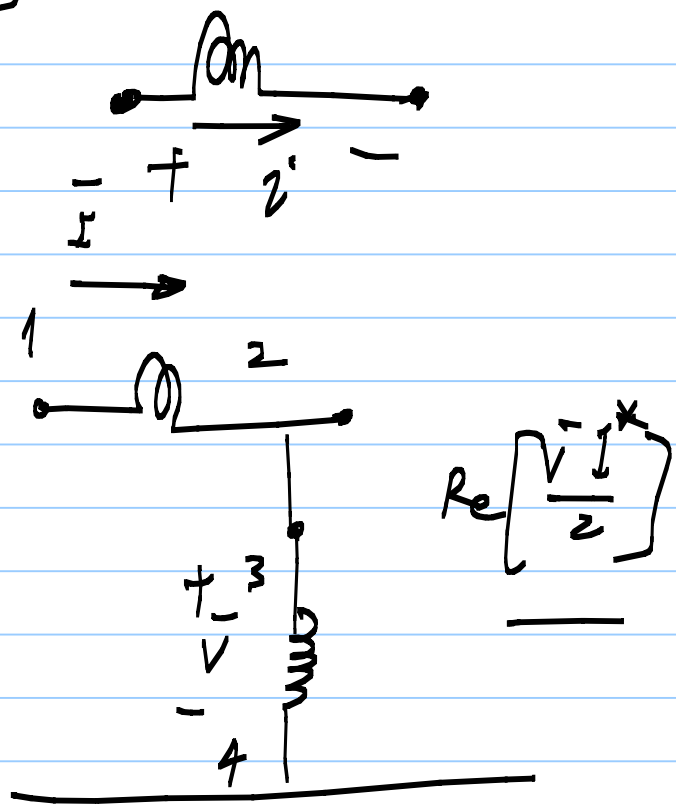
$$P_{av} = \frac{3}{2} V_p I_p \cos\phi$$

$$PF = \frac{\frac{V_p I_p}{2}\cos\phi}{|P_{per\,phase}|}$$

Wattmeter;



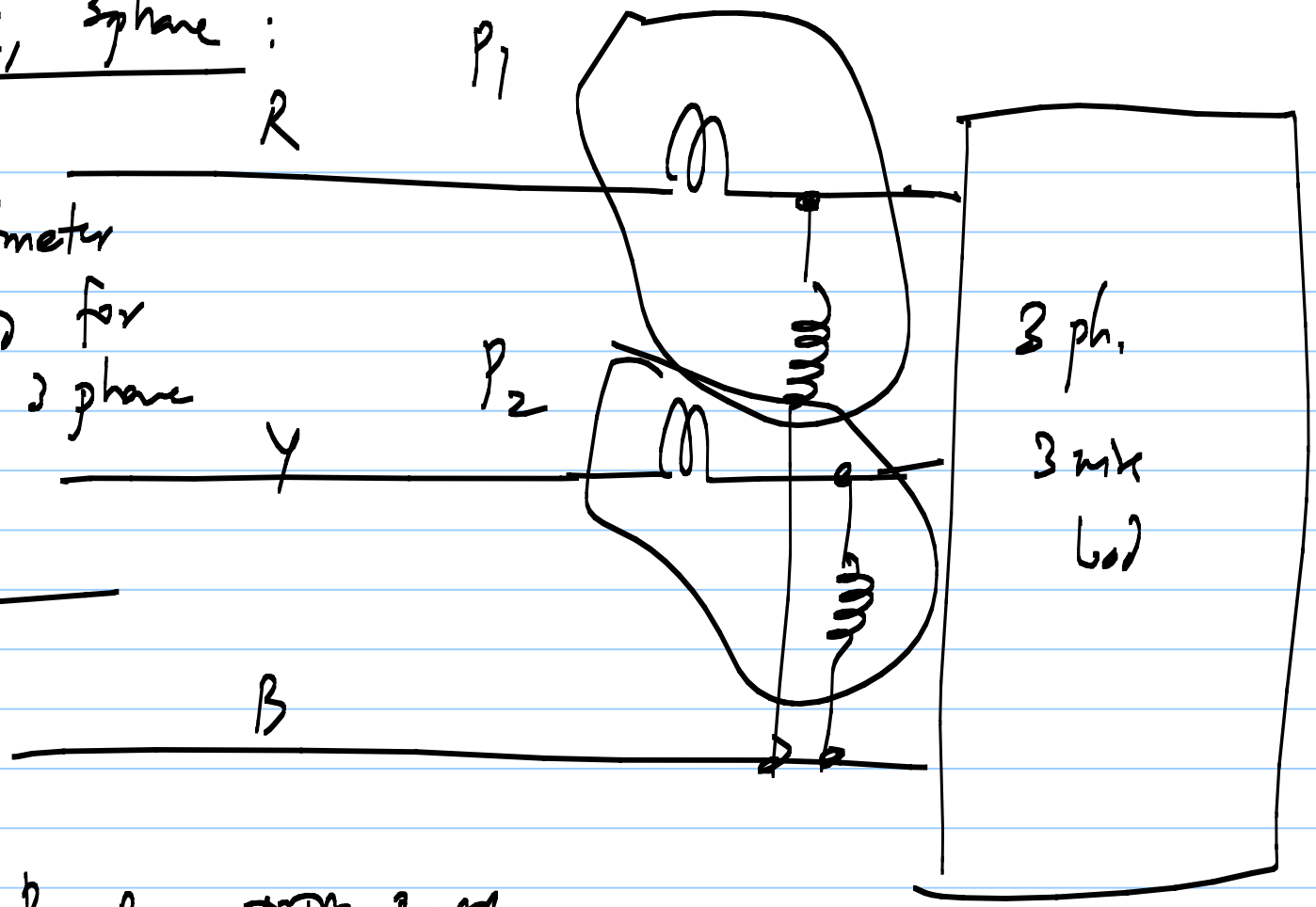
$$\mathrm{Re}\left[\frac{\bar{V}\,\bar{I}^{*}}{2}\right]$$



$$\mathrm{Re}\left[\frac{\bar{V}\,\bar{I}^{*}}{2}\right]$$

3 wire, 3 phase :

Two wattmeter method for measuring 3 phase power



$P_1 + P_2$: TOTAL power