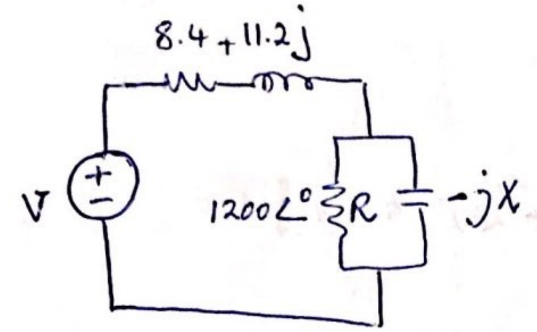
Tut. 1 / 3 phase - Power factor

Q1/



$P_R = VI \Rightarrow 30\,kVA = 1200\angle 0 \times I$

$\Rightarrow I = \dfrac{30\times 1000}{1200\angle 0} = 25$

$\cos\theta = 0.8 \Rightarrow \theta = \tan^{-1}(0.8) = 36.8°$

Distribution line impedance: $Z_d = 8.4 + 11.2j = 14\angle 53.1301°$

$\Rightarrow$ Voltage drop: $V_d = Z_d \times I = 14\angle 53.1301° \times 25\angle 36.8° = 350\angle 90°$

$\boxed{V_d = j350}$

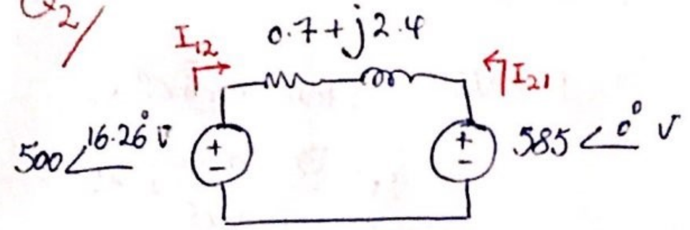
Now, $V_s = V_d + V_L = 350\angle 90° + 1200\angle 0 = 1200 + j350$

$\boxed{V_s = 1250\angle 16.26°}$

$Z_L = \dfrac{V_L}{I_L} = \dfrac{1200\angle 0}{25\angle 36.8} = 48\angle -36.8 = 29.87 + j37.57$

$Z_L = R + jX$

Q_2/



$V_1 = 500\cos(16.26) + j500\sin(16.26) = 480 + j140$

$V_2 = 585 + j0$

$Z = 0.7 + j2.4 = 2.5\angle 73.74°$

now, $I_{12} = \dfrac{V_1 - V_2}{Z} = \dfrac{480 + j140 - 585}{2.5\angle 73.74} = \dfrac{-105 + j140}{2.5\angle 73.74} = \dfrac{175\angle 126.8}{2.5\angle 73.74}$

$\Rightarrow I_{12} = 70\angle 53.06$

$S_1 = V_1 \cdot I_{12}^* = 500\angle 16.26 \times 70\angle -53.06 = 35000\angle -36.8$

$\Rightarrow \boxed{S_1 \simeq \underset{KW}{28} - j\underset{KVAR}{21}}$

$I_{21} = -I_{12} = 70\angle -126.88$

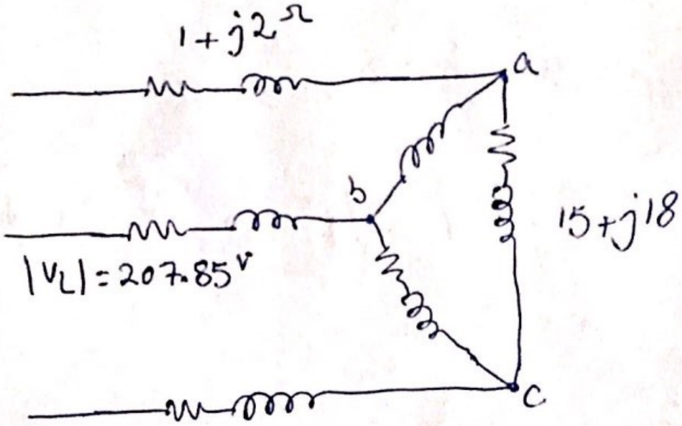
$S_2 = V_2 \cdot I_{21}^* = 585\angle 0° \times 70\angle +126.88 = 40950\angle +126.88$

$\boxed{S_2 = \underset{KW}{-24.5} + j\underset{KVAR}{32.7}}$

Line losse $= RI^2 = 0.7 \times (70)^2 = 3430\ W = 3.4\ KW$

Conclusion: Mach 2 + line losses = Mach 1 output

Q3/



(a) Step 1: Convert to single phase

Step 2: Convert delta to star load

Star equivalent for star load $= \frac{1}{3}$ (delta load)

$$= \tfrac{1}{3}(15+j18) = 5+6j$$

Step 3: Single-phase eq. cct.

$$Z_{ph} = 1+j2+5+6j = 6+8j = 10\angle 53.13^\circ$$

$$V_{L-L} = 207.85 \rightarrow V_{ph} = \frac{V_{L-L}}{\sqrt{3}} = \frac{207.85}{\sqrt{3}} \simeq 120^V$$

$$\rightarrow \text{Line Current}: I_L = \frac{V_{ph}}{Z_{ph}} = \frac{120}{10\angle 53.13} = 12\angle -53.13^\circ$$

(b) $$S_{3\text{-}ph} = 3V_{ph} \cdot I_{ph}^{*} = 3 \times 120 \times 12 \angle 53.13 \simeq 2592 + j3456$$

(c) phase voltage at load = Supply − line drop

$$\text{Line drop} = (1+2j)(12\angle -53.13) = 2.24\angle 63.435^\circ \times 12 \angle -53.13$$

$$\text{Line drop} = 26.88 \angle 10.3$$

Now, phase voltage at load $= 120 - 26.88 \angle 10.3$

$$\Rightarrow 93.55 - j\,4.8$$

Line voltage at load $= \sqrt{3} \times V_{ph} = \sqrt{3} \times \sqrt{(93.55)^2 + (4.8)^2} = \underline{\overline{162.24\ V}}$