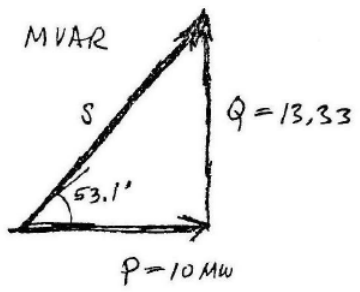
Q1)

$P = 10\ MW$, $PF = 0.6$ lagging

$\theta = \cos^{-1} 0.6 = 53.1°$

(a) $P = 10\ MW$.

$Q = P \tan\theta = 10 \tan 53.1° = 13.33\ MVAR$



(c) $\theta_{new} = \cos^{-1} 0.95 = 18.2°$

$Q_{new} = P \tan\theta_{new} = 10 \tan 18.2°$

$= 3.29\ MVAR$

$= Q_{old} + Q_{cap}$

$Q_{cap} = 3.29 - 13.33 = -10\ MVAR = -10{,}000\ KVAR$

Q2)

$Z_1 = 8 + j5\ \Omega \qquad Z_2 = 6 - j2$

$V_L = 440\ V$

$\mathbf{V}_{ph} = \frac{440}{\sqrt{3}} \angle 0° = 254 \angle 0°\ V$

(a) $I_1 = \frac{V_{ph}}{Z_1} = \frac{254 \angle 0°}{8 + j5} = 26.9 \angle -32°\ A$

$I_2 = \frac{V_{ph}}{Z_2} = \frac{254 \angle 0°}{6 - j2} = 40.2 \angle 18.4°\ A$

(b) $I_T = I_1 + I_2 = 26.9 \angle -32° + 40.2 \angle 18.4° = 61 \angle -1.5°\ A$

(c) $S_{T1} = 3S_{1ph} = 3V_{ph}I_{L1}^{*} = 3(254\angle 0^\circ)(26.9\angle -32^\circ)^*$

$= 20{,}500\angle 32^\circ = 17.4 + j10.9 \quad kVA$

$P_1 = 17.4 \ kW$

$Q_1 = 10.9 \ kVAR$

$S_{T2} = 3S_{2ph} = 3V_{ph}I_2^{*} = 3(254\angle 0^\circ)(40.2\angle 18.4^\circ)^*$

$= 30.6\angle -18.4^\circ = 29.1 - j9.7 \quad kVA$

$P_2 = 29.1 \ kW$

$Q_2 = -9.7 \ kVAR$

(d) $P_T = P_1 + P_2 = 17.4 + 29.1 = 46.5 \ kW$

$Q_T = Q_1 + Q_2 = 10.9 - 9.7 = 1.2 \ kVAR$

$S_T = \sqrt{P_T^2 + Q_T^2} = \sqrt{(46.5)^2 + (1.2)^2} = 46.5 \ kVA$

Q3)

$S_{Load} = 500MVA$, $\cos\theta = 0.866$ Lagging, Δ connected

Load $V_L = V_p = 345 kV$.

a- $Z_p = \frac{V_p}{I_p} =$, $P = \sqrt{3}V_L I_L \cos\theta = 3V_p I_p \cos\theta = 500 \times 0.866 \Rightarrow$

$I_p = \frac{P}{\sqrt{3}V_L I_L \cos\theta} = \frac{P}{3V_p \cos\theta} = \frac{500 \times 0.866}{3 \times 345 \times 10^3 \times 0.866} = 483.09\angle -30^\circ$

$Z_p = \frac{V_p}{I_p} = \frac{345\angle 0 \times 10^3}{483.09\angle -30^\circ} = 714.15\angle 30 = 618.4 + j357 \ \angle 30^\circ \ \Omega$

b) $I_{ab} = 483.09\angle -30^\circ \ A$, $I_{Line} = \sqrt{3} \times 483.09\angle 0^\circ \ A$

$I_{bc} = 483.09\angle -150^\circ \ A$ $I_b = 836.736\angle -120^\circ \ A$

$I_{ca} = 483.09\angle -270^\circ \ A$ $I_c = 836.736\angle -240^\circ \ A$

c) $P/_{Phase} = \frac{500 \times 0.866}{3} = 144.33 \ MW$ $Q/_{phase} = \frac{500 \times 0.5}{3} = \frac{250}{3} = 83.33 \ MVAR$

d) $P_T = 433 MW$ $Q_T = 250 MVAR$

Q4)

$P_1 = 50\ kW$, $V = 460\ V_{LL}$, $PF = 0.866$ lagging

$S_2 = 36\ kVA$, $V = 460\ V_{LL}$, $PF = 0.9$ leading

$Z_{Ltr} = 0.5 + j2.0\ \Omega$, $\mathbf{V}_{ph} = \frac{460}{\sqrt{3}} \angle 0^\circ = 265.6 \angle 0^\circ\ V_{LN}$

$$\mathbf{I}_1 = \frac{50{,}000 \angle -\cos^{-1} 0.866}{\sqrt{3}(460)(0.866)} = 72.46 \angle -30^\circ\ A$$

$$\mathbf{I}_2 = \frac{36{,}000}{\sqrt{3}(460)} \angle \cos^{-1} 0.9 = 45.18 \angle 25.8^\circ\ A$$

(a) $$Z_1 = \frac{265.6 \angle 0^\circ}{72.46 \angle -30^\circ} = 3.66 \angle 30^\circ\ \Omega$$

$$Z_2 = \frac{265.6 \angle 0^\circ}{45.18 \angle 25.8^\circ} = 5.88 \angle -25.8^\circ\ \Omega$$

(b) $$\mathbf{I}_T = \mathbf{I}_1 + \mathbf{I}_2 = 72.46 \angle -30^\circ + 45.18 \angle 25.8^\circ = 104.7 \angle -9.1^\circ$$

(c) $$\mathbf{V}_B = \mathbf{V}_{ph} + Z_{Ltr}\mathbf{I}_T = 265.6 \angle 0^\circ + (0.5 + j2.0)(104.7 \angle -9.1^\circ)$$

$$= 402.7 \angle 29.5^\circ\ V_{LN}$$

$$= 697.5 \angle 59.5^\circ\ V_{LL}$$

(d) $$S_B = \sqrt{3}\mathbf{V}_B \mathbf{I}_T^* = \sqrt{3}(697.5 \angle 29.5^\circ)(104.7 \angle -9.1^\circ)^*$$

$$= 126.5 \angle 38.6^\circ\ kVA$$

$$= 98.86 + j78.92\ kVA$$

$P_B = 98.86\ kW$

$Q_B = 78.92\ kVAR$