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1. $V_{load-phase} = \frac{|V_{load-ll}|}{\sqrt{3}} \angle 0^\circ = \frac{650}{\sqrt{3}} \angle 0^\circ = 375.4 \angle 0^\circ$

$S_{load1} = V_{load-ph}^2 / \bar{Z}_{load1} = 1586.99 + j4760.96$ W

For load 2: $\bar{Z}_{load2} = \frac{\bar{Z}_\Delta}{3} = 3.25$, $S_{load2} = V_{load-ph}^2 / \bar{Z}_{load2} = 4878.5 + j7317.75$

$S_{load-1\phi} = S_{load1} + S_{load2} = 4878.5 + j7317.75$

$S_{load-total} = \sqrt{3}\, S_{load-1\phi} = 11598.56 + j20120.54$ W

2. 


$P_{load1.1\phi} = 240 \times 0.6 = 144$  $Q_{load1.1\phi} = 144$

pf new = 0.9 lag $\Rightarrow \theta = 25.84^\circ \Rightarrow Q_{load1.new} = 104.6$ kVAr

$Q_{comp} = -39.4$ kVAr $= |V_{cap}| \cdot |I_{cap}| \cdot \sin(-90^\circ)$

$\Rightarrow |I_{cap}| = 82$ A $\Rightarrow |\bar{Z}_{cap}| = |V_{cap}| / |I_{cap}| = 1.9\ \Omega$

$\Rightarrow \frac{1}{\omega C} = 5.9\ \Omega$, $\omega = 2\pi f \Rightarrow C = 0.00044$ F

3. $P_{load-3\phi} = 1.2$ MW $\Rightarrow S_{load-3\phi} = 1.5$ MVA $\Rightarrow S_{load-1\phi} = 0.5$ MVA

$|V_{load.LL}| = 4.2$ kV $\Rightarrow V_{load.LN} = 2.4 \angle 0^\circ$ kV

$I = \frac{S^*}{|V|} = 500{,}000 \angle -36.87^\circ / 2400 = 208 \angle -36.87^\circ$ A

$V_{line.LN} = I_{line} \cdot \bar{Z}_{line} = (116.4 - j124.8)(0.5 + j1) = 208 + j104$ V

$V_{source.LN} = V_{line.LN} + V_{load.LN} = 2608 + j104$ V

$V_{s.3\phi} = \sqrt{3} \cdot 2610 = 4520.8$

$S_{source.3\phi} = 3(2608 + j104)(116.4 + j124.8) = 0.90$ MW $+ j0.34$ MVAr

$S_{s.3\phi} = 3 S_{s.1\phi} = 1.26$ MW $+ j1.02$ MVA

4. (a) $V_{b2.LL} = V_{b1.LL} \frac{V_{T1.2}}{V_{T1.1}} = 13.5$ kV, $V_{b3.LL} = V_{b2.LL} \frac{V_{T2.2}}{V_{T2.1}} = 3.0$ kV, $V_{b4.LL} = V_{b2.LL} \frac{V_{T3.2}}{V_{T3.1}} = 13$ kV

(b) $I_{b1} = \frac{S_{b.3\phi}}{\sqrt{3} V_{b1.LL}} = \frac{100\ MVA}{\sqrt{3}\ 25\ kV} = 230.4$ A, $\bar{Z}_{b1} = \frac{(V_{b1\ LN})^2}{S_{1\phi}} = 6.25\ \Omega$

(c) $\bar{Z}_{T1.pu\ (new)} = j0.08 \frac{V_{T1.1.LN}^2}{S_{T1.3\phi}} \cdot \frac{S_{b.3\phi}}{V_{b1.LL}^2} = j0.1$

$\bar{Z}_{T2.pu\ (new)} = j0.1 \frac{V_{T2}^2.1.LN}{S_{T1.3\phi}} \cdot \frac{S_{b.3\phi}}{V_{b2.LL}^2} = j0.125$

5. (a) $I_{line-pu} = I_{load2.pu} = 0.12 - j0.08$ A.pu

$V_{B2.pu} = V_{B4.pu} + I_{line.pu}(\bar{Z}_{line.pu} + \bar{Z}_{T2.pu}) = 1.0288 + j0.0328$ V.pu

$I_{gen.pu} = I_{load1.pu} + I_{line.pu} = 0.356 - j0.1885$ A.pu

$V_{B1.pu} = V_{B2.pu} + I_{gen.pu} * Z_{T1.pu} = 1.045\angle 0 + j\,0.0628$

(b) $V_{B2} = V_{B2.pu} * V_{B2.LL} = 24\angle 1.2 + j\,187.2\,V$

(c) $S_{load1} = S_{load1.pu} * S_{B.1\phi} = 72\,kW + 36\,kVAr$

$S_{load2} = S_{load2.pu} * S_{B.1\phi} = 36\,kW + 24\,kVAr$

$\Rightarrow S_{load} = 108\,kW + 60\,kVAr$