(1)

A three-phase Y-Δ transformer is rated 225-kV:24-kV (line to line), 400 MVA and has a single-phase equivalent series reactance of 6.08Ω (as referred to its high-voltage terminals).

The transformer is supplying a load of 375 MVA at 0.89 power factor leading at a voltage of 24 kV (line to line) on its low-voltage side. It is supplied from a feeder whose impedance is $0.17 + j2.2\Omega$ (connected to its high-voltage terminals).

For these conditions, calculate

(a) the line-to-line voltage at the high-voltage terminals of the transformer

(b) the line-to-line voltage at the sending end of the feeder.

Homework 5

(a) $U_L = \frac{24kV}{\sqrt{3}} = 13.86\ kV$

$I_L = \frac{317\ MVA}{\sqrt{3}24kV} e^{j\phi} = 9.021\, e^{j\phi}\ kA$

$\phi = \cos^{-1} 0.89 = 27.12°$

Turn ratio $N = \frac{225}{24} = 9.375$

$\therefore \quad \dot{U}_L' = N\dot{U}_L = 9.375 \times 13.86 = 129.9\ kV$

$\dot{I}_L' = \frac{\dot{I}_L}{N} = \frac{9.021\, e^{j\phi}}{9.375} = 0.9622\, e^{j\phi}\ kA$

High-side line neutral terminal voltage:

$$U_H = |\dot{U}_L' + j X_t \dot{I}_L'| = |129.9 + j\,6.08 \times 0.9622 \angle 27.12°| = 127.3kV$$

Line-line voltage:

$\sqrt{3} \times 127.3 = 220.49\ kV$

(b) $U_S = |\dot{U}_L' + (Z_f + j X_t)\dot{I}_L'| = |129.9 + (0.17 + j2.2) \cdot 6.08 \cdot 0.9622 \angle 27.12°| = 125.5kV$

Line-line voltage:

$\sqrt{3} \times 125.5 = 217.4$