

Problem 6-17

Transformer per phase:

ratings: 5 kVA, $V_{pri} = 120V$ at 60 Hz, $X_{Ls} = 8\%$

$$Z_{base} = \frac{V^2}{(VA)} = \frac{120^2}{5000} = 2.88 \Omega$$

$$\therefore L_s = 0.08 \times \frac{Z_{base}}{\omega (=377)} = 0.61 \text{ mH}$$

Minimum transformer turns ratio = a ,

where $\frac{V_{pri}}{V_{sec}} = a$.

Therefore,

$$V_d = \frac{1.35}{a} V_{LL} \cos \alpha - \frac{3 \omega L_s}{\pi} I_d$$

In vigorous calculations, we should use $\left(\frac{L_s}{a^2}\right)$

Substitute $V_d = 300V$, $\alpha = 0^\circ$ and $V_{LL}^{min} = 208V (-10\%) = 187.2V$,

$$\text{Also, } I_d = \frac{12,000}{300} = 40A$$

$$\therefore a_{min} = 0.818$$

With $a_{min} = 0.818$ and $V_{LL} = 208V (+5\%) = 218.4V$,

$$\alpha = 31^\circ \text{ for } V_d = 300V.$$