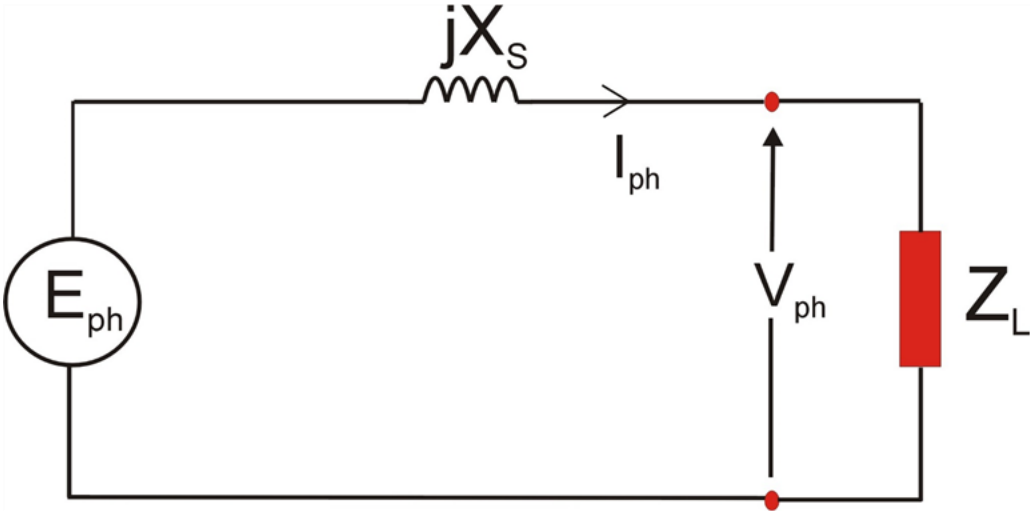
Examples Synchronous Generators

1. A star connected 3-phase wound field synchronous generator with a synchronous reactance Xs of 25Ω is connected to a 9kV (line) grid and supplies 1MW at 0.863 lagging power factor at its terminals. Evaluate the following:
    a. The phase current.
    b. The resultant voltage V_{XS} across the synchronous reactance.
    c. The required excitation voltage (E_{ph}).
    d. The load angle (δ).

Solution



For this question we need to consider the equivalent circuit

a.

$$\text{Pout}=3\times\frac{V_L}{\sqrt{3}}\times I_{ph}\times \text{ power factor}$$

$$=\sqrt{3}\times|V_L|\times|I_{ph}|\times \text{ power factor}$$

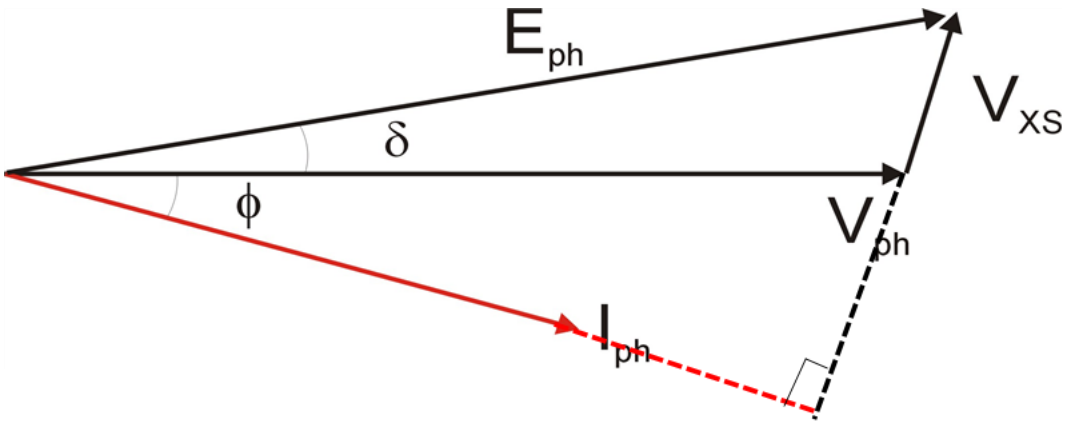
$$\therefore|I_{ph}|=\frac{1\times10^6}{\sqrt{3}\times9000\times0.863}=74.33A$$

$$so: I_{ph}=74.33\angle\cos^{-1}0.863=74.33\angle-30.34^o\,A$$

b.

$$V_{xs}=I_{ph}\times jX_s=74.33\angle-30.38^o\times25\angle90^o$$

$$=1858\angle59.66^oV$$



c.

$$E_{ph} = V_{ph} + V_{xs}$$

$$= \frac{9000}{\sqrt{3}} + 1858\angle 59.66^{o} = 6341\angle 14.68^{o} V$$

d. $\delta = 14.645^{o}$