\[ I_1 \text{ on 7200 V side} = \frac{100,000}{7200} = 13.9 \text{ A} \]
\[ I_2 \text{ on 600 V side} = \frac{100,000}{600} = 166.7 \text{ A} \]

We can load the transformer until \( I_2 = 166.7 \text{ A} \)

\[ \therefore \text{ The input to the transformer can be } 166.7 \times 7800 = 1300 \text{ kVA}. \text{ The load is also } 1300 \text{ kVA} - 13 \text{ times greater than the nameplate rating of the transformer.} \]

Total: 5 points.

11-8 The primary and secondary voltages must add; therefore \( H1 - X2 \) or \( H2 - X1 \) must be connected together.

Total: 5 points.
Total: 5 points. 3 points for the Figure. 2 points for the load calculation.

Total: 5 points. 2.5 points for each subproblem.
a. The rated current in the primary windings is:

\[ I_p = \frac{100 000}{13 200} = 7.57 \text{ A} \]

This current must not be exceeded when the transformers are connected as shown above. The max. load is:

\[ S = EI \sqrt{3} = 18 000 \times 7.57 \times \sqrt{3} = 236 \text{ kVA} \]

b. \[ E_2 = 2.4 \times \frac{18}{\sqrt{3}} \times \frac{1}{13.2} = 1.89 \text{ kV} \]

Total: 5 points. 2.5 points for each subproblem.

\[ I_2 = 400 \times 10^3 / 600 \sqrt{3} = 385 \text{ A} \]

Nominal value of \[ I_s = \frac{250 000}{600} = 417 \text{ A} \]

a. The transformers are not overloaded.
b. The max load is \[ 417 \times 600 \sqrt{3} = 433 \text{ kVA} \].
Total:  5 points. 2.5 points for each subproblem.

25-11 a.

\[ E_R = \left( \frac{6000}{285 + 15} \right) \times 285 = 5700 \text{ V} \]

\[ P = \frac{E_R^2}{R} = \frac{5700^2}{285} = 114 \text{ kW} \]

\[ E_R = \left( \frac{6000}{60} \right) \times 45 = 4500 \text{ V} \]

\[ P = \frac{450^2}{45} = 450 \text{ kW} \]

\[ P = \frac{3000^2}{15} = 600 \text{ kW} \]

\[ E_R = \left( \frac{6000}{20} \right) \times 5 = 1500 \text{ V} \]

\[ P = \frac{1500^2}{5} = 450 \text{ kW} \]

Total:  10 points. 8 points for the voltage and real power calculations. 2 points for the Figure.
25-13 a. 

\[ Z \text{ of circuit} = \sqrt{15^2 + 285^2} = 285.39 \, \Omega \]
\[ I = \frac{6000}{285.39} = 21.02 \, \text{A} \]
\[ E_R = 21.02 \times 285 = 5992 \, \text{V} \]
\[ P = \frac{E_R^2}{R_{\text{load}}} = \frac{5992^2}{285} = 126 \, \text{kW} \]

\[ E_R = \frac{6000}{\sqrt{15^2 + 45^2}} \times 45 = 5692 \, \text{V} \]
\[ P = \frac{5692^2}{45} = 720 \, \text{kW} \]

\[ E_R = \frac{6000}{\sqrt{15^2 + 15^2}} \times 15 = 4243 \, \text{V} \]
\[ P = \frac{4243^2}{15} = 1200 \, \text{kW} \]

\[ E_R = \frac{6000}{\sqrt{15^2 + 5^2}} \times 5 = 1897 \, \text{V} \]
\[ P = \frac{1897^2}{5} = 720 \, \text{kW} \]

Total: 10 points. 8 points for the calculation of different variable. 2 points for the Figure.

25-12 They are in the same phase.

Total: 5 points.
According to the phasor diagram $E_R$ lags behind $E_S$. We have $I = \frac{5692}{45} = 126.5$ A
length of phasor $IX = 126.5 \times 15 = 1897$ V
$\therefore \theta = \arctan \frac{1897}{5692} = 18.4^\circ$

Total: 5 points. 3 points for the calculation. 2 points for indicating the leading or lagging relationship.

25-15 a.

$Z = 285 - 15 = 270$
$I = \frac{6000}{120} = 22.22$ A
$E_R = 22.22 \times 285 = 6333.33$ V

$Z = 45 - 15 = 30$ $\Omega$
$I = \frac{6000}{30} - 200$ A
$E_R = 200 \times 45 = 9000$ V
b. \[ I = 200 \text{ A leading } \\
E_R \text{ by } 90^\circ \]
\[ E_X = 200 \times 15 = 3000 \text{ V} \]
leading \( I \) by 90°

\( E_R \) is in phase with \( E_S \).

Total: 10 points. 6 points for a). 4 points for b).

25-16 a. \[ Z = \sqrt{15^2 + 45^2} = 47.43 \ \Omega \]
\[ I = \frac{6000}{47.43} = 126.5 \ \text{A} \]
\[ E_R = 126.5 \times 45 = 5692 \ \text{V} \]

b. No, a capacitor only raises the voltage for inductive lines, or lines that have some inductance in addition to their resistance.

Total: 5 points. 3 points for a), 2 points for b).
a. \( Q_c = \frac{6000^2}{150} = -240 \text{ kvar} \) (the minus sign only indicates that the power is capacitive).

b. Power to load = \( \frac{6000^2}{45} = 800 \text{ kW} = P \)

\[
S_1 = \sqrt{P^2 + Q_c^2} = \sqrt{800^2 + 240^2} = 835.2 \text{ kVA}
\]

\[
I = \frac{S_1}{E_R} = \frac{835.2}{6000} = 139.2 \text{ A.}
\]

c. \( Q_L = I^2X_{\text{Line}} = 139.2^2 \times 15 = +290.65 \text{ kvar} \)

d. reactive power at input line is

\( Q_s = Q_L + Q_c = 290.65 - 240 = +50.65 \text{ kvar} \)

because \( Q_s \) is positive the line absorbs reactive power from the source.

e. active power input to line = 800 kW

\[
S_2 = \sqrt{P^2 + Q_s^2} = \sqrt{800^2 + 50.65^2} = 801.6 \text{ kVA}
\]

f. \( E_s = \frac{S_2}{I} = \frac{801.6}{139.2} = 5759 \text{ V} \)

g. If \( E_s = 6 \text{ kV,} \) the value of \( E_R \) increases in proportion:

\[
E_R = \frac{6000}{5759} \times 6000 = 6251 \text{ V}
\]

Note that the capacitor raises the terminal voltage considerably. In effect, without the capacitor the voltage was found to be 5692 V (see Problem 25-13).

The power is \( P = \frac{6251^2}{45} = 868 \text{ kW} \)

Total: 10 points. 1.5 points for each subproblem.
25-18 We can use standard circuit techniques to calculate the phase angle, but we shall use another approach that is sometimes useful.

The power factor at the load terminals is:

\[ \cos \theta_1 = \frac{P}{S_1} = \frac{800}{835.2} = 0.958 \quad \therefore \theta_1 = 16.7^\circ \]

The current \( I \) leads \( E_R \) by 16.7° because of the capacitor.

The power factor at the source is

\[ \cos \theta_2 = \frac{P}{S_2} = \frac{800}{801.6} = 0.998 \quad \therefore \theta_2 = 3.6^\circ \]

We found that \( Q_s \) was positive, indicating that \( I \) lags behind \( E_s \) (by 3.6°). We conclude that \( E_R \) lags behind \( E_s \) by an angle \( \theta = 3.6 + 16.7 = 20.3^\circ \)

Total: 5 points. 3 points for the calculation. 2 points for indicating the leading or lagging relationship.
25-21 a.

\[ P = \frac{E^2}{X} \sin \delta \]
\[ = \frac{230^2}{43} \sin 20^\circ \]
\[ = 421 \text{ MW} \]

b.

\[ I = ? \]

The phase angle between \( E_s \) and \( E_R = 20^\circ \) also we write the circuit equation:

\[-E_s + j 43 I + E_R = 0 \quad : \quad I = j \frac{(E_R - E_s)}{43} \]

Letting \( E_R = 133 \angle 0 \text{ kV} \) we have \( E_s = 133 \angle +20 \text{ kV} \)

\[ E_R - E_s = 46.2 \angle -80^\circ \text{ kV} \quad : \quad I = \frac{46200}{43} = \angle +10^\circ \]
\[ = 1074 \angle +10^\circ \text{ A} \]
c. Reactive power absorbed by the line:

\[ Q = 3 \, I^2 X_L = 3 \times 1074^2 \times 43 = 148.8 \, \text{Mvar} \]

d. The phase angle between \( E_s \) and \( I \) and \( E_R \) and \( I \) is 10°; the power factor at the sender and receiver is therefore the same \( \cos \theta = \cos 10 = 0.9848 \). The apparent power for both is

\[ S = P/\cos \theta = 421/0.9848 = 427.5 \, \text{MVA} \]

\[ Q_s = Q_R = \sqrt{427.5^2 - 421^2} = 74.3 \, \text{Mvar} \]

Total: 10 points. 2.5 points for each subproblem.