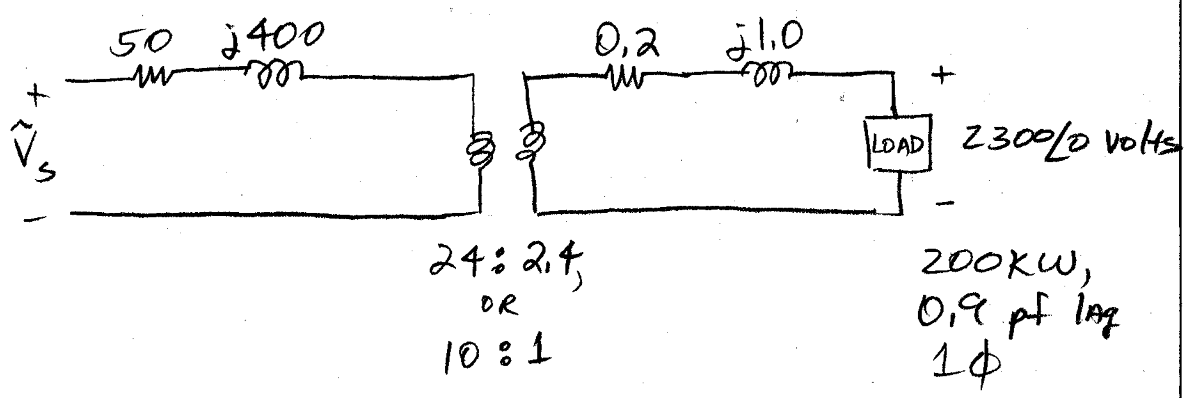
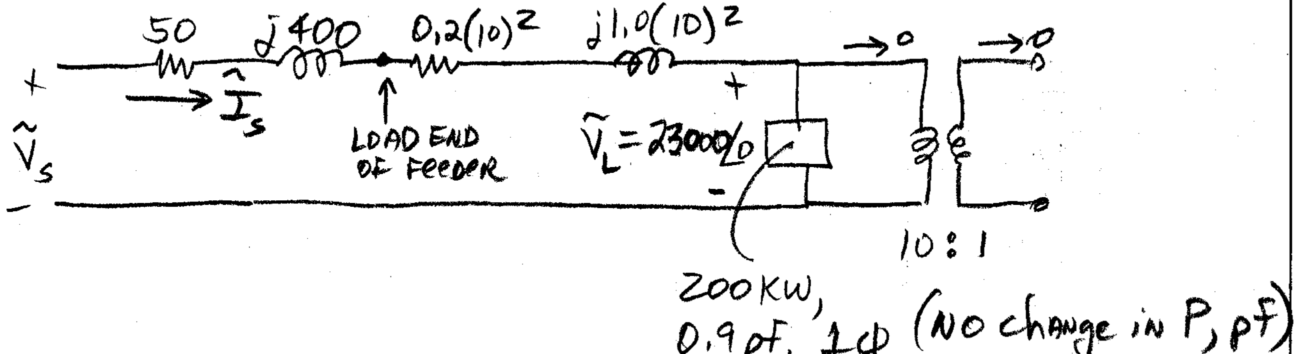
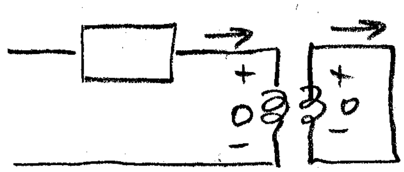
5.5



Reflect all to the 24 kV side makes the problem easier



You can also think of the load connection as a shorted transformer in series with the load



Get $\tilde{I}_s$ from the load condition,

$$\tilde{V}_L \hat{I}_s^{*} = S_L = \frac{P_L}{pf}\angle \cos^{-1}(pf) = \frac{200000}{0.9}\angle +25.8^\circ$$

(lagging current gives + Q)

$$\tilde{I}_s^{*} = \frac{222000\angle 25.8^\circ}{23000\angle 0} = 9.65\angle 25.8$$

$$\hat{I}_s = 9.65\angle -25.8 \text{ A}$$

$$\tilde{V}_s = \tilde{V}_L + \tilde{I}_s Z = (23000\angle 0) + (9.65\angle -25.8)(50 + j400 + 20 + j100)$$

$$= 23000 + (9.65\angle -25.8)(505\angle 82^\circ)$$

$$\bar{V}_s = 23000 + 4873\angle 56.2 = 23000 + 2711 + j4049$$

(a) $\boxed{\hat{V}_s = 25711 + j4049 = 26028\angle 8.9^\circ \text{ V}}$ (a 13% rise in mag from the load)

5.5, cont

At the load end of the feeder,

$$\tilde{V}_{FEED} = 23000\angle 0 + (9.65\angle{-25.8})\underbrace{(20 + j100)}_{102.0\angle 78.7}$$

$$= 23000\angle 0 + 984\angle 52.9$$

(b) $$\tilde{V}_{FEED} = 23000 + 594 + j784 = 23594 + j784 = 23607\angle 1.9°$$

a 2.6% rise

(c) $$S_s = \tilde{V}_s \hat{I}_s = (26028\angle 8.9)(9.65\angle 25.8) = 251170\angle 34.7$$

$$S_s = 206{,}498 + j142{,}986$$

$$P_s + jQ_s$$

$$P_L = 200000$$

$$\eta = \frac{P_L}{P_s} = \frac{200000}{206498} = 0.969$$

Also, $$\eta = \frac{P_L}{P_L + P_{LOSS}} = \frac{200000}{200000 + (9.65)^2\underbrace{(50+20)}_{\text{ckt Resistance}}} = 0.968$$

If no load, $|\tilde{V}_L| = |\tilde{V}_s| = 26028$

so $$\% V_{Reg} = \frac{|V_L|_{NL} - |V_L|_{FL}}{|V_L|_{FL}} = \frac{26028 - 23000}{23000} \cdot 100\%$$

$$= 13.2\%$$