2-7. A 5000-kVA 230/13.8-kV single-phase power transformer has a per-unit resistance of 1 percent and a per-unit reactance of 5 percent (data taken from the transformer's nameplate). The open-circuit test performed on the low-voltage side of the transformer yielded the following data:

$$V_{OC} = 13.8\ \text{kV} \qquad I_{OC} = 15.1\ \text{A} \qquad P_{OC} = 44.9\ \text{kW}$$

(a) Find the equivalent circuit referred to the low-voltage side of this transformer.

(b) If the voltage on the secondary side is 13.8 kV and the power supplied is 4000 kW at 0.8 PF lagging, find the voltage regulation of the transformer. Find its efficiency.

2-10. A 13,800/480 V three-phase Y-Δ-connected transformer bank consists of three identical 100-kVA 7967/480-V transformers. It is supplied with power directly from a large constant-voltage bus. In the short-circuit test, the recorded values on the high-voltage side for one of these transformers are

$$V_{SC} = 560\ \text{V} \qquad I_{SC} = 12.6\ \text{A} \qquad P_{SC} = 3300\ \text{W}$$

(a) If this bank delivers a rated load at 0.85 PF lagging and rated voltage, what is the line-to-line voltage on the primary of the transformer bank?

2-22. A single-phase 10-kVA 480/120-V transformer is to be used as an autotransformer tying a 600-V distribution line to a 480-V load. When it is tested as a conventional transformer, the following values are measured on the primary (480-V) side of the transformer:

Open-circuit test	Short-circuit test
$V_{OC} = 480$ V	$V_{SC} = 10.0$ V
$I_{OC} = 0.41$ A	$I_{SC} = 10.6$ A
$V_{OC} = 38$ W	$P_{SC} = 26$ W

(a) Find the per-unit equivalent circuit of this transformer when it is connected in the conventional manner. What is the efficiency of the transformer at rated conditions and unity power factor? What is the voltage regulation at those conditions?

(b) Sketch the transformer connections when it is used as a 600/480-V step-down autotransformer.

(c) What is the kilovoltampere rating of this transformer when it is used in the autotransformer connection?

(d) Answer the questions in *(a)* for the autotransformer connection.

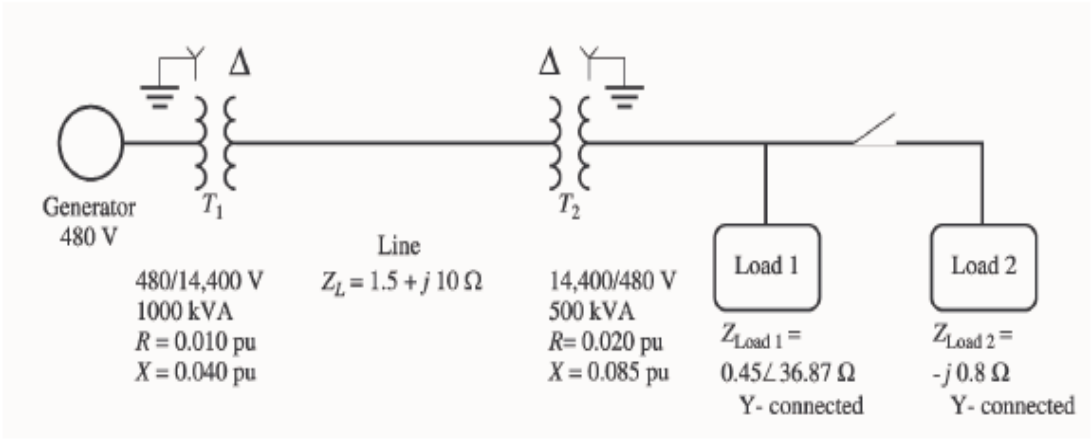
2-23. Figure P2-4 shows a power system consisting of a three-phase 480-V 60-Hz generator supplying two loads through a transmission line with a pair of transformers at either end.

(a) Sketch the per-phase equivalent circuit of this power system.

(b) With the switch opened, find the real power P, reactive power Q, and apparent power S supplied by the generator. What is the power factor of the generator?

(c) With the switch closed, find the real power P, reactive power Q, and apparent power S supplied by the generator. What is the power factor of the generator?

(d) What are the transmission losses (transformer plus transmission line losses) in this system with the switch open? With the switch closed? What is the effect of adding Load 2 to the system?



Region 1	**Region 2**	**Region 3**
$S_{base1} = 1000$ kVA	$S_{base2} = 1000$ kVA	$S_{base3} = 1000$ kVA
$V_{L,base2} = 480$ V	$V_{L,base2} = 14{,}400$ V	$V_{L,base3} = 480$ V