

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
ELECTRICAL ENGINEERING DEPARTMENT

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EE-463

Key Solution

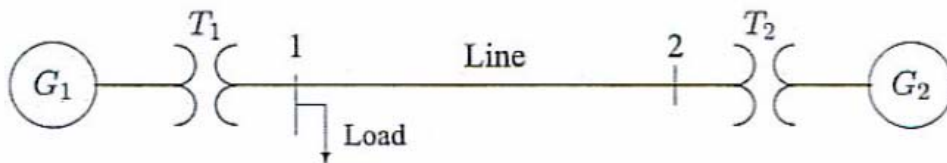
Quiz # 1 Serial #

Name:

I.D.#

Draw an impedance diagram for the electric power system shown in Figure 26 showing all impedances in per unit on a 100-MVA base. Choose 20 kV as the voltage base for generator. The three-phase power and line-line ratings are given below.

G_1 :	90 MVA	20 kV	$X = 9\%$
T_1 :	80 MVA	20/200 kV	$X = 16\%$
T_2 :	80 MVA	200/20 kV	$X = 20\%$
G_2 :	90 MVA	18 kV	$X = 9\%$
Line:	200 kV		$X = 120 \Omega$
Load:	200 kV		$S = 48 \text{ MW} + j64 \text{ Mvar}$



The base voltage V_{BG1} on the LV side of T_1 is 20 kV. Hence the base on its HV side is

$$V_{B1} = 20 \left(\frac{200}{20} \right) = 200 \text{ kV}$$

This fixes the base on the HV side of T_2 at $V_{B2} = 200$ kV, and on its LV side at

$$V_{BG2} = 200 \left(\frac{20}{200} \right) = 20 \text{ kV}$$

The generator and transformer reactances in per unit on a 100 MVA base, from (3.69) and (3.70) are

$$G: \quad X = 0.09 \left(\frac{100}{90} \right) = 0.10 \text{ pu}$$

$$T_1: \quad X = 0.16 \left(\frac{100}{80} \right) = 0.20 \text{ pu}$$

$$T_2: \quad X = 0.20 \left(\frac{100}{80} \right) = 0.25 \text{ pu}$$

$$G_2: \quad X = 0.09 \left(\frac{100}{90} \right) \left(\frac{18}{20} \right)^2 = 0.081 \text{ pu}$$

The base impedance for the transmission line is

$$Z_{BL} = \frac{(200)^2}{100} = 400 \ \Omega$$

The per unit line reactance is

$$\text{Line: } X = \left(\frac{120}{400} \right) = 0.30 \text{ pu}$$

The load impedance in ohms is

$$Z_L = \frac{(V_{L-L})^2}{S_{L(3\phi)}^*} = \frac{(200)^2}{48 - j64} = 300 + j400 \ \Omega$$

The load impedance in per unit is

$$Z_{L(pu)} = \frac{300 + j400}{400} = 0.75 + j1.0 \text{ pu}$$

The per unit equivalent circuit is shown in Figure 27.

