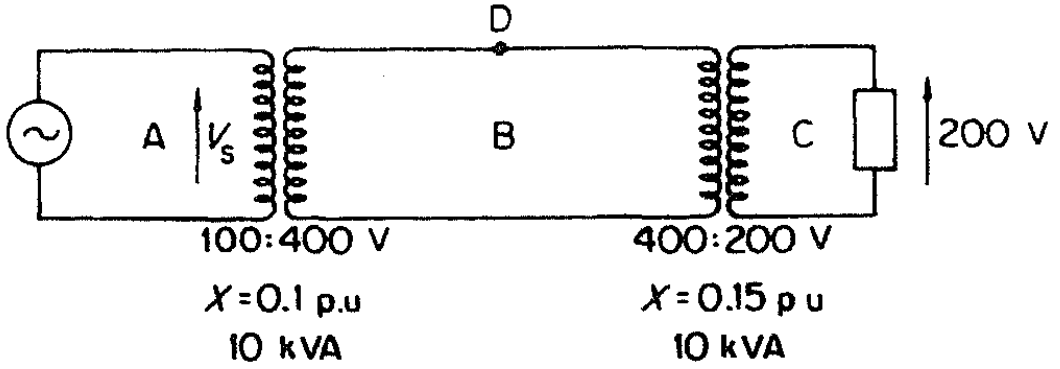
8.17 Example

In the network below, two single-phase transformers supply a 10 kVA resistance load at 200 V. Show that the p.u. load is the same for each part of the circuit and calculate the voltage at point D.




*Solution*

The load resistance is $(200^2/10 \times 10^3)$, i.e. 4 Ω.

In each of the circuits A, B, and C a different voltage exists, so that each circuit will have its own base voltage, i.e. 100 V in A, 400 V in B, and 200 V in C.

Although it is not essential for rated voltages to be used as bases, it is essential that the *voltage bases used be related by the turns ratios of the transformers*. If this is not so

the whole p.u. framework breaks down. The same volt-ampere base is used for all the circuits as $V_1 I_1 = V_2 I_2$ on each side of a transformer and is taken in this case as 10 kVA. The base impedance in C

$$= \frac{200^2}{10\,000} = 4\ \Omega$$

The load resistance (p.u.) in C

$$= \frac{4}{4} = 1 \text{ p.u.}$$

In B the base impedance

$$= \frac{400^2}{10\,000} = 16\ \Omega$$

and the load resistance referred to B

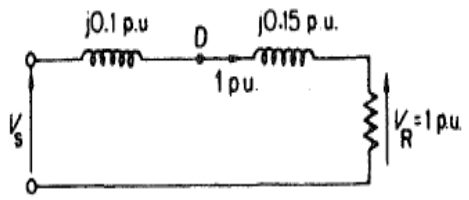
$$= 4 \times 2^2 = 16\ \Omega$$

Hence the p.u. load referred to B

$$= 1 \text{ p.u.}$$

Similarly, the p.u. load resistance referred to A is also 1 p.u. Hence, if the voltage bases are related by the turns ratios the load p.u. value is the same for all circuits. An equivalent circuit may be used as shown in Figure 2.18. Let the volt-ampere base be 10 kVA; the voltage across the load ($V_R$) is 1 p.u. (as the base voltage in C is 200 V, if the load voltage had been maintained at 100 V, then $V_R$ would be 0.5 p.u.). The base current

$$= \frac{(VA)_b}{V_b} = \frac{10\,000}{200} = 50 \text{ A in C}$$



The corresponding currents in the other circuits are 25 A in B, and 100 A in A. The actual load current = 50/50 = 1 p.u. (in phase with $V_R$, the reference phasor). Hence the supply voltage $V_s$

$$= 1(j0.1 + j0.15) + 1 \text{ p.u.}$$

$$\therefore V_s = 1.03 \text{ p.u.}$$

$$= 1.03 \times 100 = 103 \text{ V}$$

The voltage at point D in Figure 2.17

$$= 1 + j0.15 \times 1 = 1 + j0.15$$

$$= 1.012 \text{ p.u.modulus}$$

$$= 1.012 \times 400 = 404.8 \text{ V}$$

It is a useful exercise to repeat this example using ohms, volts, and amperes.