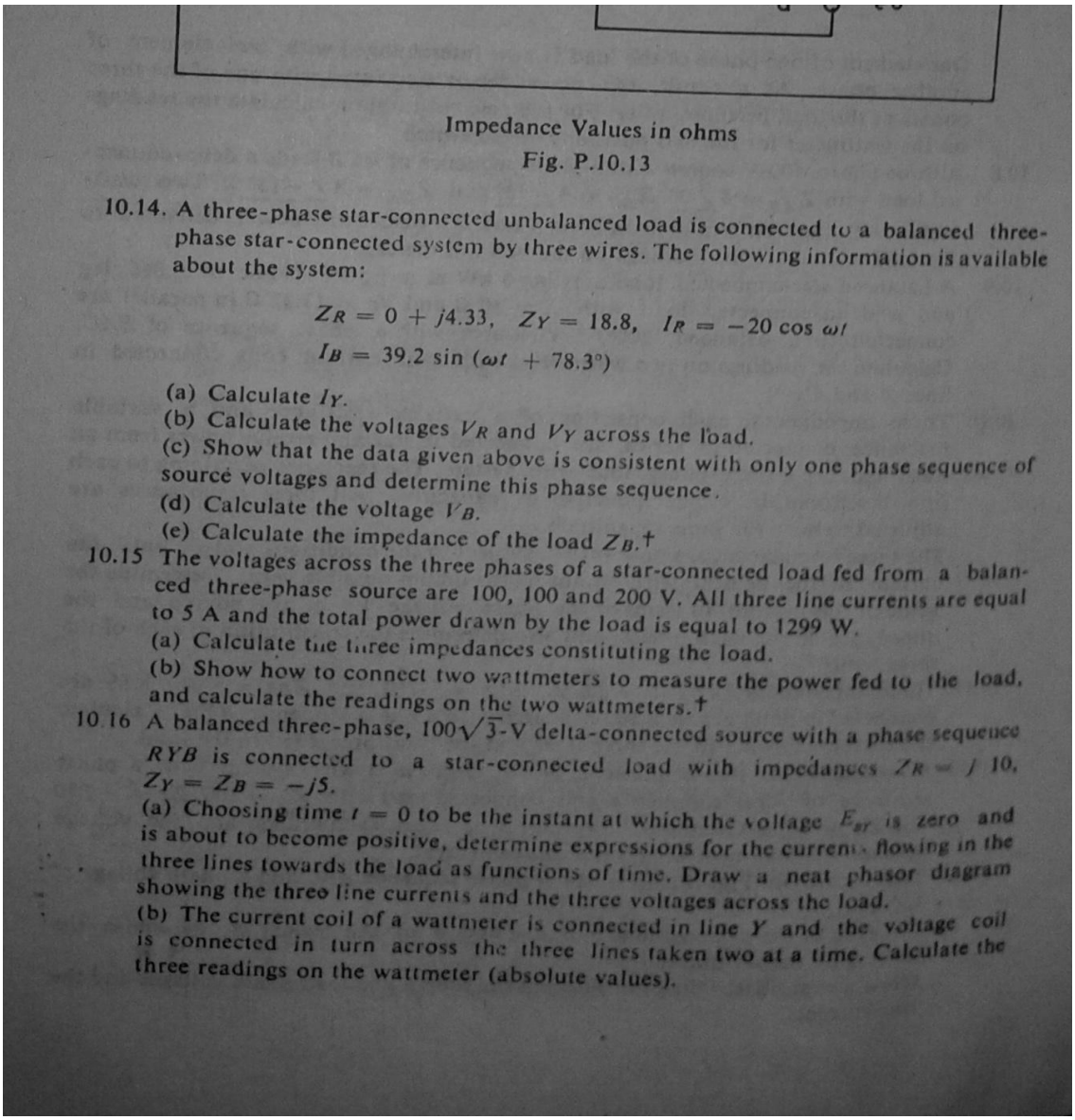
ELECTRIC AND MAGNETIC CIRCUITS : TUTORIAL 5
SCANS FROM MURTHY & KAMATH, BASIC CIRCUIT ANALYSIS



Impedance Values in ohms

Fig. P.10.13

10.14. A three-phase star-connected unbalanced load is connected to a balanced three-phase star-connected system by three wires. The following information is available about the system:

$$Z_R = 0 + j4.33, \quad Z_Y = 18.8, \quad I_R = -20 \cos \omega t$$
$$I_B = 39.2 \sin (\omega t + 78.3°)$$

(a) Calculate I_Y.
(b) Calculate the voltages V_R and V_Y across the load.
(c) Show that the data given above is consistent with only one phase sequence of source voltages and determine this phase sequence.
(d) Calculate the voltage V_B.
(e) Calculate the impedance of the load Z_B.†

10.15 The voltages across the three phases of a star-connected load fed from a balanced three-phase source are 100, 100 and 200 V. All three line currents are equal to 5 A and the total power drawn by the load is equal to 1299 W.
(a) Calculate the three impedances constituting the load.
(b) Show how to connect two wattmeters to measure the power fed to the load, and calculate the readings on the two wattmeters.†

10.16 A balanced three-phase, $100\sqrt{3}$-V delta-connected source with a phase sequence RYB is connected to a star-connected load with impedances $Z_R = j10$, $Z_Y = Z_B = -j5$.
(a) Choosing time $t = 0$ to be the instant at which the voltage E_{RY} is zero and is about to become positive, determine expressions for the currents flowing in the three lines towards the load as functions of time. Draw a neat phasor diagram showing the three line currents and the three voltages across the load.
(b) The current coil of a wattmeter is connected in line Y and the voltage coil is connected in turn across the three lines taken two at a time. Calculate the three readings on the wattmeter (absolute values).

Solve Problems 10.14, 10.15 and 10.16

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10.17 A pure resistance, a pure inductance and a pure capacitance are connected in star to a 400-V, 50-Hz three-phase system. The line currents are 4, 12 and 16 A (not necessarily respectively). Net reactive power input to the load is negative. Determine R, L and C.†

10.18 The voltages across two of the phases in a three-phase star-connected load fed from a balanced three-wire system are each $100\sqrt{2}$ V, the phase angle between them being 90°. One phase in the system has a pure resistance in it, while the two others are series RC combinations.
If the three line currents are all equal to 20 A, calculate the impedances of the load, specifying clearly the impedance in each phase. Draw a neat phasor diagram to illustrate the conditions in the network.†

10.19 A pure resistance, a pure inductance and a pure capacitance, all with finite, non-zero values, are connected in star accross a balanced 200-V AC source by three wires. The three corresponding line ammeters all read 20 A each. Calculate the values of the three branch impedances and the total power input to the load. Also determine the phase sequence of the supply (which should be specified as RLC or as RCL depending upon the connections of the three elements).†

10.20 Six pure elements of which only one is an inductance go to make up the three impedances of a star-connected load receiving power from an ideal, three-phase, balanced 200-V source via three wires, in each of which there is a switch.
The power output of the source and the line current, with two of the line switches closed at a time, are found to be 3,200 W and 20 A in all three cases. Calculate the impedances of the load and the power output of the source when all three switches are closed.†

10.21 A three-phase star-connected load is made up of two resistances and a capacitance and is connected by three wires to a three-phase, 200-V source with a phase sequence ACB. There is a switch in line C. When this switch is open, the current flowing is 5 A. When this switch is closed, currents in lines A and B do not change but the current in line C becomes 10 A.
Calculate the three load impedances and also the reading on a wattmeter connected with its current coil in line A and its voltage coil across lines AC, for both positions of the switch in line C.†

10.22 An unbalanced load is connected to a balanced $200\sqrt{3}$-V source by four wires. One of the impedances in the load is a pure resistance. There is a switch S in the neutral wire, which is initially open.
It is observed that all three line currents are equal initially. When S is closed, only the current in the resistive load changes. The current in the neutral wire is now 15 A. Calculate the impedance in each phase of the load.†

10.23 An unbalanced reactive load is connected by 4 wires to a balanced 100-V source. There is a switch in each wire. Initially S_N the switch in the neutral wire is open and the other three switches are closed two at a time. The current flowing is observed to be 10 A when the switches S_R and S_Y in lines R and Y or S_Y and S_B in lines Y and B are closed and 5 A when S_R and S_B are closed. In the latter case the reactive power input to the load is 500 VAR.
(a) Determine the three impedances of the load.
(b) With all three line switches closed, calculate the currents in the lines and draw a phasor diagram showing these currents and the three phase voltages.
(c) The switch in the neutral wire is also closed. Determine the current in the neutral wire.†

10.24 The source connected to the three-phase load in Fig. P.10.24 is a balanced 100-V source with a phase sequence RYB. Initially, S_R and S_B are open and S_Y is closed.
(a) When S_R is closed the ammeter A_x reads 5 A.
(b) When S_B is also closed, A_Y and A_B read 5 A.

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Solve Problems 10.17 through 10.23

10.25 A balanced three-phase 100-V source with a phase sequence RYB is connected to a three-phase reactive load by 4 wires, in each of which there is a switch. Initially S_N is open and the three other switches are closed two at a time with the following results. S_Y, S_R closed—current 13.3 A; S_Y, S_B closed—current 40 A; S_B, S_R closed—current 5 A. In the last case, the reactive power input to the load is 500 VAR.

(a) Determine the three load impedances Z_R, Z_Y and Z_B.

(b) With all three line switches closed, determine the currents in the three lines.

(c) With all four switches closed, determine the current in the neutral wire.†

10.26 An unbalanced delta-connected load has three impedances $Z_{AB} = 16 + j3$, $Z_{BC} = 15 - j8$ and $Z_{CA} = 10 + j8$. When connected to an ideal, three-phase (not necessarily balanced) source, it is observed that the three line currents are:

$$I_A = 25, \quad I_C = I_B = 30 \text{ A}.$$

(a) Calculate the currents flowing in each of the loads.

(b) Draw a phasor diagram to represent the three load currents, the three line currents and the three line voltages at an instant of time when the current in line C has its maximum value.

10.27 In Fig. P.10.27,

(a) Calculate the currents flowing in each of the loads.

(b) The terminals of the wattmeter marked COM and V are connected in turn to A and B, B and C, and finally to C and A. Calculate the reading on the wattmeter in each case.

(c) Draw a phasor diagram showing the three phase currents, the three line currents and the three line voltages.

10.28 Fig. P.10.28 shows three impedances Z_A, Z_B and Z_C connected in star and receiving power from a star-connected three-phase, three-wire system. The three phase voltages of the source are equal in magnitude, but the phase angles between them are not 120°.

The current coil of an ideal wattmeter is connected in line A. One terminal of its voltage coil is connected to line A and the other to a switch S which can be connected to any one of the six terminals a, b, c, d, e or f.

At a particular instant of time it is observed that the line currents I_A and I_C flowing towards the load can be represented by the complex numbers

Solve Problems 10.25 to 10.27

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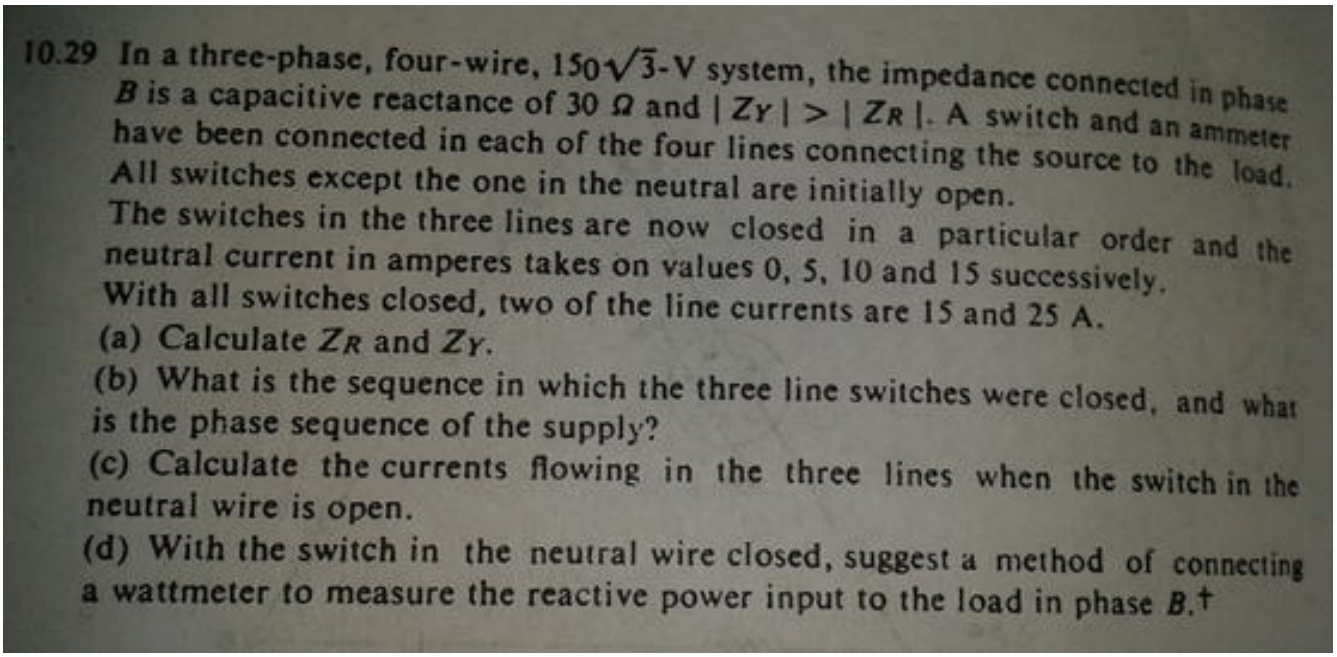

10.29 In a three-phase, four-wire, $150\sqrt{3}$-V system, the impedance connected in phase B is a capacitive reactance of 30 Ω and $|Z_Y| > |Z_R|$. A switch and an ammeter have been connected in each of the four lines connecting the source to the load. All switches except the one in the neutral are initially open.

The switches in the three lines are now closed in a particular order and the neutral current in amperes takes on values 0, 5, 10 and 15 successively. With all switches closed, two of the line currents are 15 and 25 A.

(a) Calculate Z_R and Z_Y.

(b) What is the sequence in which the three line switches were closed, and what is the phase sequence of the supply?

(c) Calculate the currents flowing in the three lines when the switch in the neutral wire is open.

(d) With the switch in the neutral wire closed, suggest a method of connecting a wattmeter to measure the reactive power input to the load in phase B.†

Solve problem 10.29