Date: ______________

Name: ____________________________

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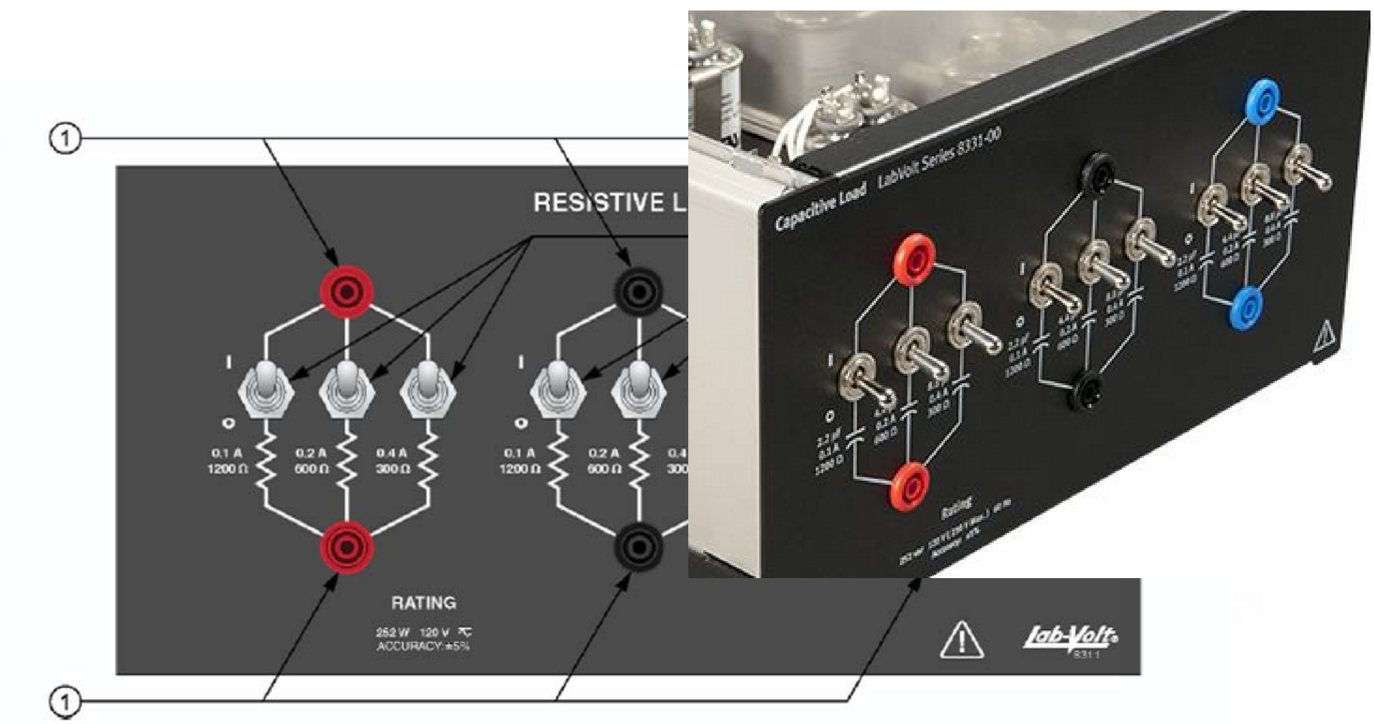
LABORATORY EXPERIMENT NO. 2

PHASE SEQUENCE



OBJECT

To determine the phase sequence of a three-phase source.

DISCUSSION

The phase sequence of a three-phase source is the time order in which its three line voltages succeed each other, that is, the order in which they attain their maximum positive values. A knowledge of phase sequence is important when other three-phase lines are to be connected in parallel or when the direction of rotation of large motors must be known in advance. Phase sequence is also important in many three-phase metering devices such as sequence relays and varmeters. If the phase sequence is not checked, the readings may be quite different from what they should be.

Phase sequence is usually indicated on bus-bars by a color code of some kind, or it may be found by using a phase sequence indicator, commercially available. In the absence of such a device, the phase sequence can be found by connecting in wye two equal resistors and a capacitor to the three terminals of the power source as shown in *Fig. 2-1*. The voltages across the two resistors will be found to be unequal and the phase sequence is in the order, (high voltage) - (low voltage) - (capacitor). For example, if the voltages across the resistors are *20V* and *80V* as shown in *Fig. 2-1*, the phase sequence is B-A-C. The voltages succeed each other in the sequence B-A-C-B-A-C; hence the sequence B-A-C is the same as the sequence A-C-B or the sequence C-B-A.

The phase sequence of a three-phase line can be changed by interchanging any two conductors. On small power set-ups this is an easy task, but on large transmission lines and heavy bus-bars, such a conductor change is a major, costly, job. For this reason the desired phase sequence on large power installations is thought out well in advance.

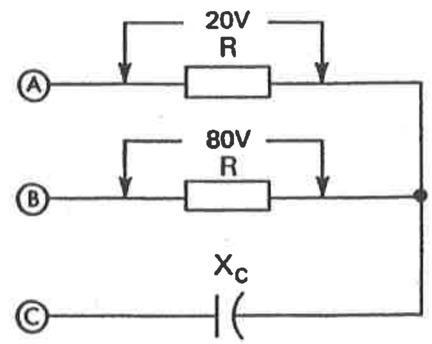


Fig. 2-1

MULTIPLE OUTLETS

In some installations (such as in a laboratory) a number of receptacles may be fed from a common bus. These receptacles may have terminals marked, say, 1-2-3 and, following the procedures we have just outlined, the phase sequences can everywhere be established in the order 1-2-3. *Fig. 2-2* shows how three receptacles P, Q, R may be connected in this way to the main bus, whose phase sequence is in the order A-B-C. The phase sequence of each receptacle is in the order 1-2-3 but it is obvious that if terminal 1 of receptacle P is connected to terminal 1 of receptacle R a short-circuit will result. In other words, correct phase sequence is not a guarantee that similarly-marked terminals may be connected together.

The only way to be sure that the connections are identical for various receptacles is to measure the voltage between similarly-marked terminals. If

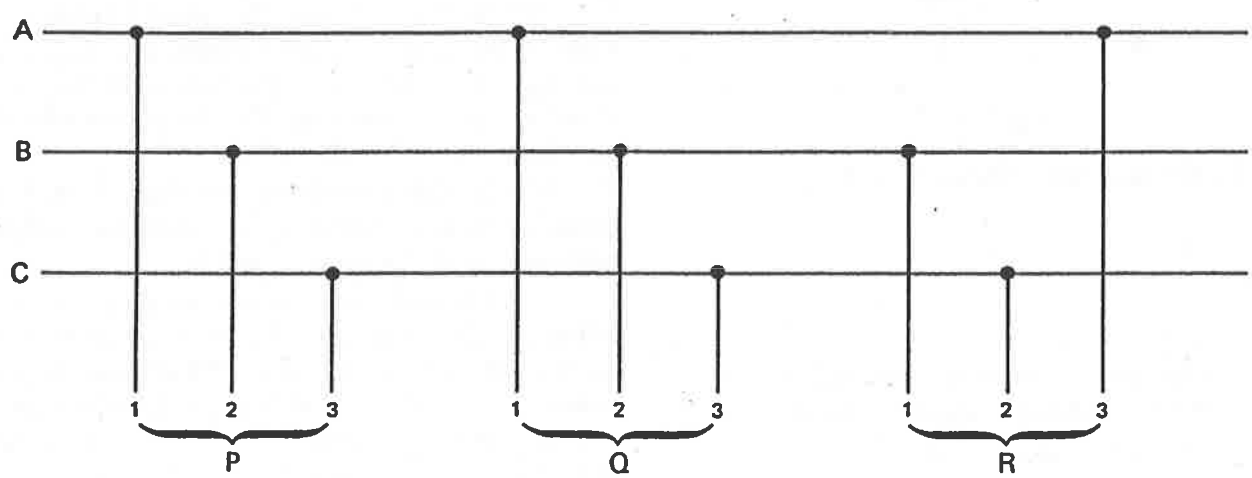


Fig. 2-2

the voltage is zero in every case, the phase sequence *and* the connections are identical.

INSTRUMENTS AND COMPONENTS

Power Supply Module (2) *(120/208V 3φ, 0-120/208V 3φ)*	*EMS 8821*
Resistance Module	*EMS 8311*
Capacitance Module	*EMS 8331*
AC Metering Module *(250/250/250V)*	*EMS 8426*
Connection Leads	*EMS 9128*

EXPERIMENTS

Caution: High voltages are present in this Laboratory Experiment! Do not make any connections with the power on!

☐ 2-1) Using your EMS resistance, capacitance and metering modules, connect the circuit to the power supply as shown in *Fig. 2-3.* Set the value of each resistor to *300 ohms,* and set the capacitive reactance also to *300 ohms.* Note that the three elements are connected in wye to terminals 1-2-3 of the power supply.

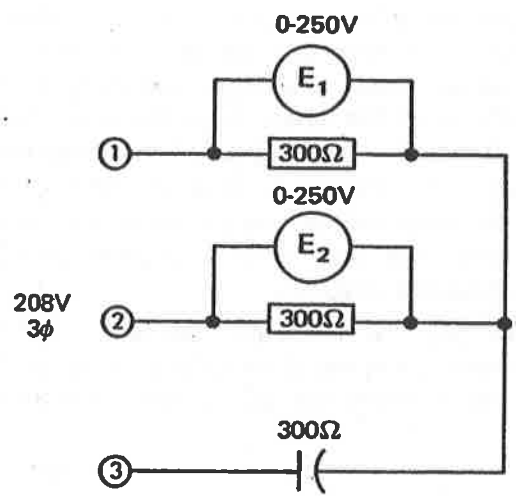


Fig. 2-3

☐ 2-2) Measure the voltages E_1 and E_2.

E_1 = ...

E_2 = ...

☐ 2-3) Determine the phase sequence (1-2-3 or 2-1-3) from the relative values of E_1 and E_2.

The phase sequence is ....

☐ 2-4) If the phase sequence is found to be 2-1-3 it is preferable to interchange any two of the phase wires of the wall receptacle to which the power supply is connected.

(It is much easier to remember a phase sequence when it is 1-2-3, and in all subsequent experiments we shall assume this sequence has been established).

☐ 2-5) Connect the circuit of *Fig. 2-3* to terminals 4-5-6 of the power supply, and determine the phase sequence.

The phase sequence is ....

Note: If the sequence is 5-4-6 instead of 4-5-6 follow the procedure given in 2-4. It is much easier to recall a phase sequence of 4-5-6 and in all subsequent experiments we shall assume this sequence).

☐ 2-6) Connect the three voltmeters to power supply terminals 1-4, 2-5 and 3-6, respectively. Rotate the variable auto-transformer completely in the clockwise direction, and turn on the power supply. The three voltmeters should read zero.

Next, rotate the variable auto-transformer completely counterclockwise. The three voltmeters should read about the same and the voltage should be between *110* and *130 volts.*

E_{1-4} = ...

E_{2-5} = ...

E_{3-6} = ...

The purpose of this test is to ensure that your power supply is operating correctly.

☐ 2-7) In *Fig. 2-5,* draw the phasor diagram to scale of the power supply voltages E_{12}, E_{23}, E_{31} and E_{1N}, E_{2N} and E_{3N}, based upon the diagrams given in *Fig. 2-4* showing the phasor relationship for phase sequence 1, 2, 3 and 1, 3, 2.

Repeat this experiment for all the wall receptacles in the laboratory, and make the necessary wiring changes if required. This wiring check is particularly useful for future experiments where different consoles will be linked together by transmission lines.

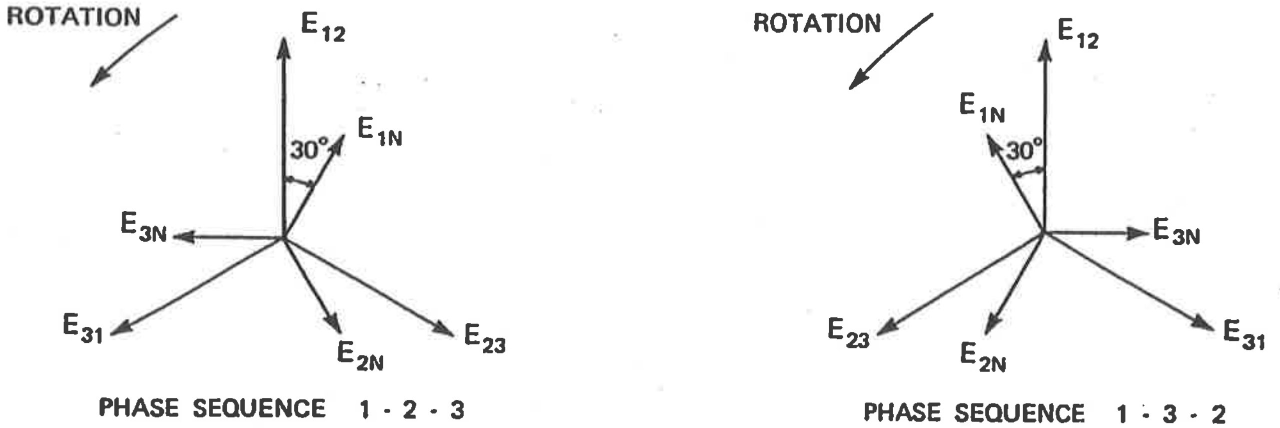


Fig. 2-4

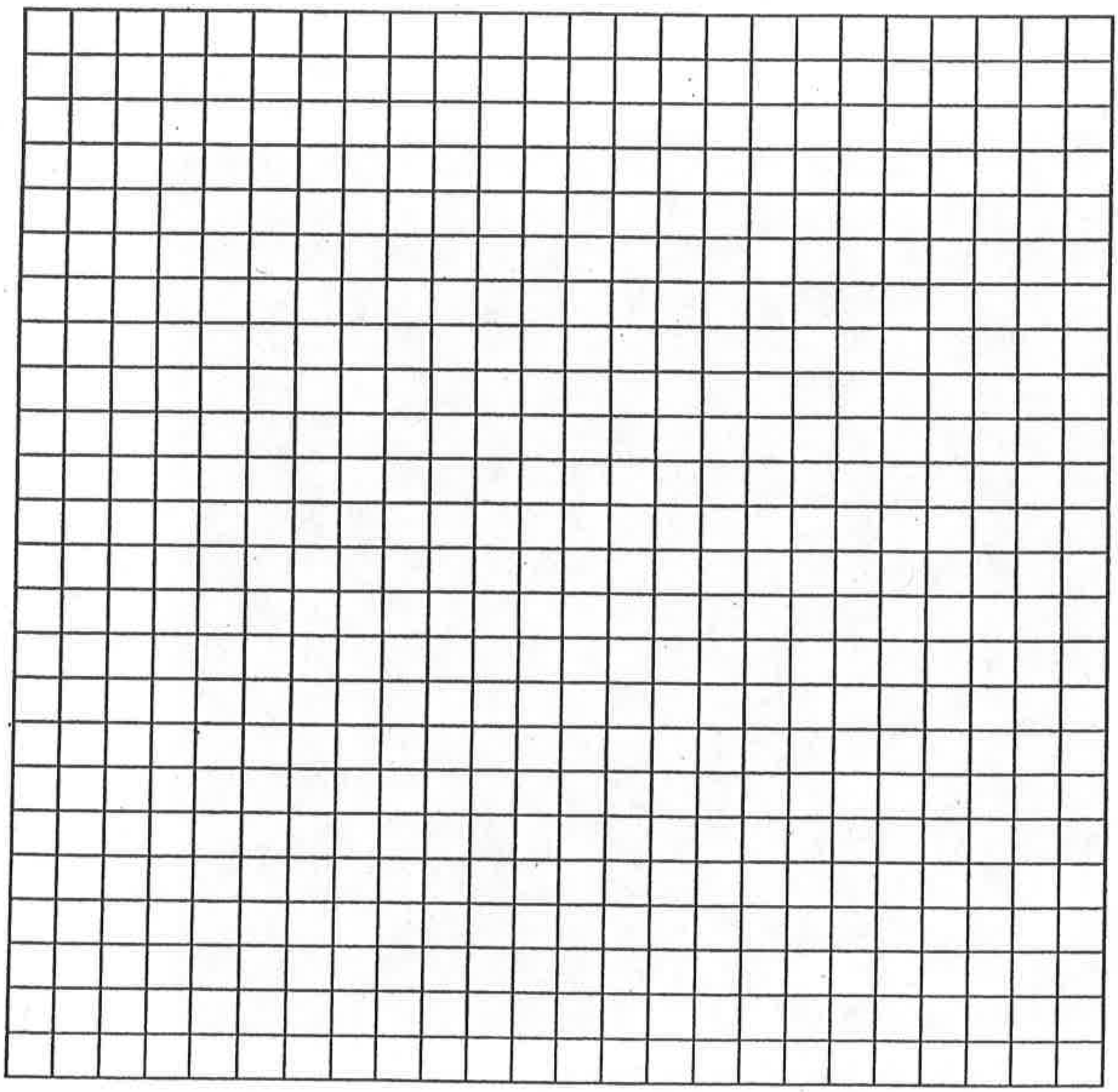


Fig. 2-5

note