Chapter: 03

Electrical Supply Systems:

Lecture : 16

TOPIC:

1. Four wires star connected unbalanced load,

Examples.

Chapter: 03
Electrical Supply Systems:

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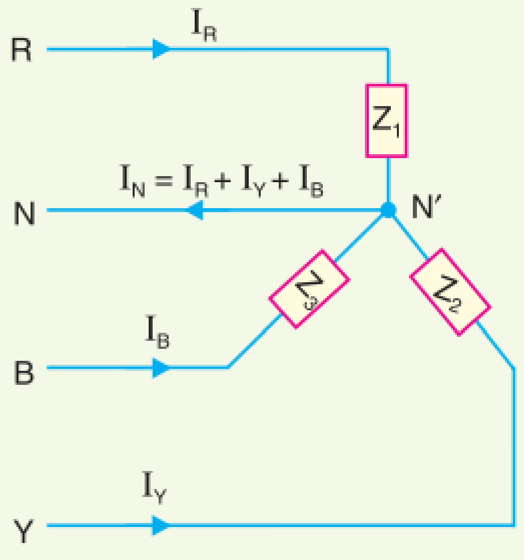


Fig. 14.10

14.4 Four-Wire Star-Connected Unbalanced Loads

We can obtain this type of load in two ways. First, we may connect a 3-phase, 4-wire unbalanced load to a 3-phase, 4-wire supply as shown in Fig. 14.10. Note that star point N of the supply is connected to the load star point N'. Secondly, we may connect single phase loads between any line and the neutral wire as shown in Fig.14.11. This will also result in a 3-phase, 4-wire **unbalanced load because it is rarely possible that single phase loads on all the three phases have the same magnitude and power factor. Since the load is unbalanced, the line currents will be different in magnitude and displaced from one another by unequal angles. The current in the neutral wire will be the phasor sum of the three line currents *i.e.*

Current in neutral wire, $I_N = I_R + I_Y + I_B$ *...phasor sum*

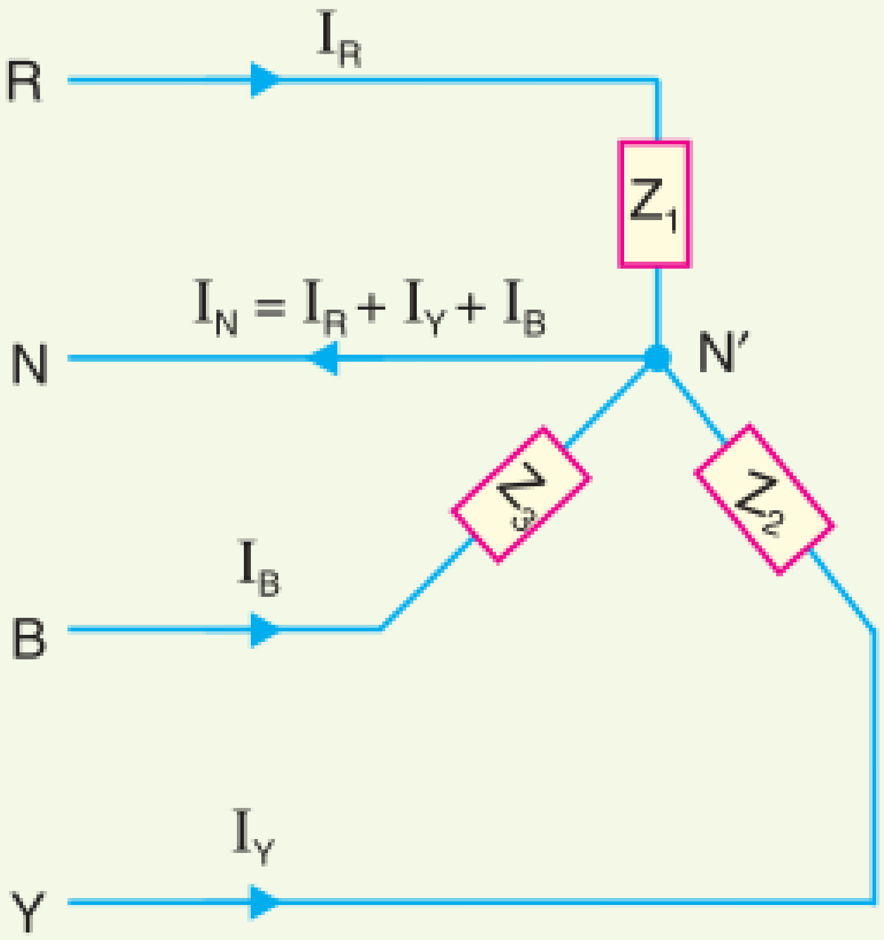


Fig. 14.10

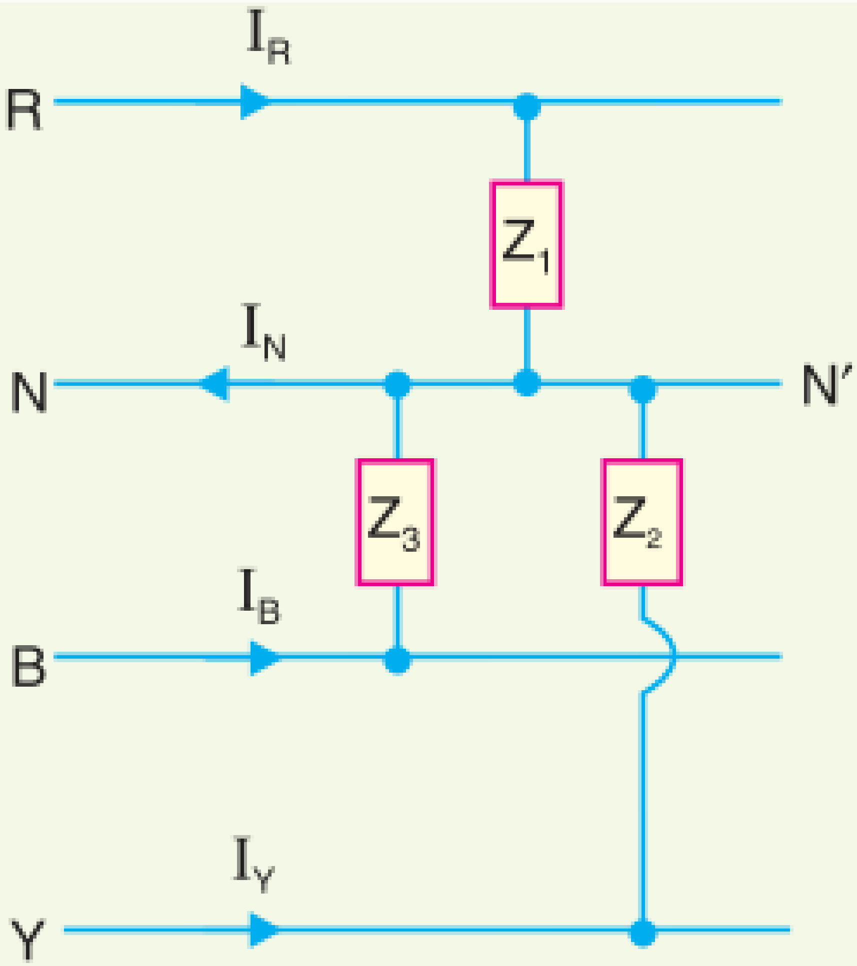


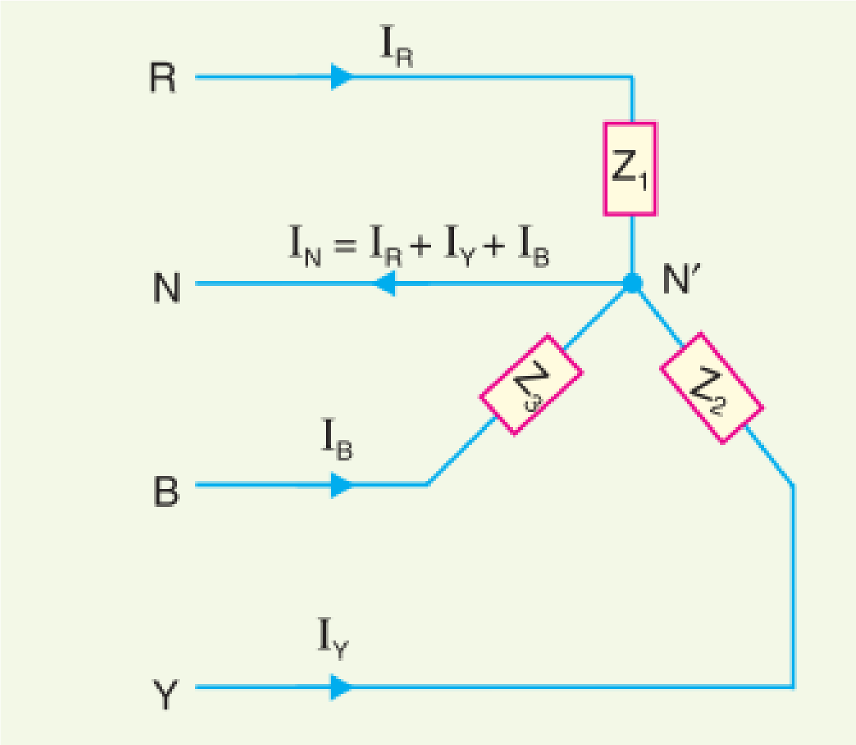
Fig. 14.11

The following points may be noted carefully :

(*i*) Since the neutral wire has negligible resistance, supply neutral N and load neutral N' will be at the same potential. It means that voltage across each impedance is equal to the phase voltage of the supply. However, current in each phase (or line) will be different due to unequal impedances.

(*ii*) The amount of current flowing in the neutral wire will depend upon the magnitudes of line currents and their phasor relations. In most circuits encountered in practice, the neutral current is equal to or smaller than one of the line currents. The exceptions are those circuits having severe unbalance.

Example 14.7. *Non-reactive loads of 10 kW, 8 kW and 5 kW are connected between the neutral and the red, yellow and blue phases respectively of a 3-phase, 4-wire system. The line voltage is 400V. Calculate (i) the current in each line and (ii) the current in the neutral wire.*



$$
\begin{aligned}
I_R &= 10 \times 10^3/231 = \mathbf{43{\cdot}3\ A} \\
I_Y &= 8 \times 10^3/231 = \mathbf{34{\cdot}6\ A} \\
I_B &= 5 \times 10^3/231 = \mathbf{21{\cdot}65\ A}
\end{aligned}
$$

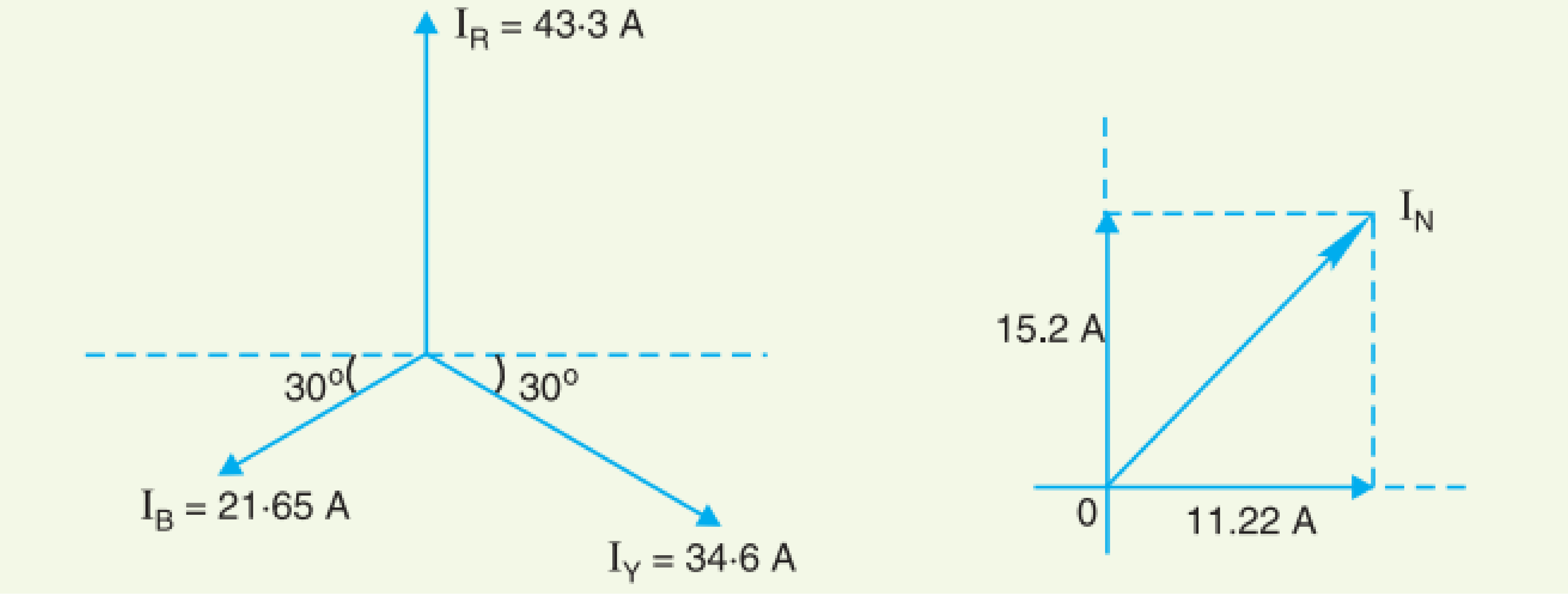
(*ii*) The three lines currents are represented by the respective phasors in Fig. 14.13. Note that the three line currents are of different magnitude but displaced 120° from one another. The current in the neutral wire will be the phasor sum of the three line currents.

Resolving the three currents along *x*-axis and *y*-axis, we have,

$$
\begin{aligned}
\text{Resultant horizontal component} &= I_Y \cos 30^\circ - I_B \cos 30^\circ \\
&= 34{\cdot}6 \times 0{\cdot}866 - 21{\cdot}65 \times 0{\cdot}866 = 11{\cdot}22\ \text{A} \\
\text{Resultant vertical component} &= I_R - I_Y \cos 60^\circ - I_B \cos 60^\circ \\
&= 43{\cdot}3 - 34{\cdot}6 \times 0{\cdot}5 - 21{\cdot}65 \times 0{\cdot}5 = 15{\cdot}2\ \text{A}
\end{aligned}
$$

As shown in Fig. 14.14, current in neutral wire is

$$
I_N = \sqrt{(11 \cdot 22)^2 + (15 \cdot 2)^2} = \mathbf{18{\cdot}9\ A}
$$


$I_R = 43{\cdot}3$ A
30°
30°
$I_B = 21{\cdot}65$ A
$I_Y = 34{\cdot}6$ A
I_N
15.2 A
0
11.22 A

Thank You