Elektrische Aandrijvingen

WTB

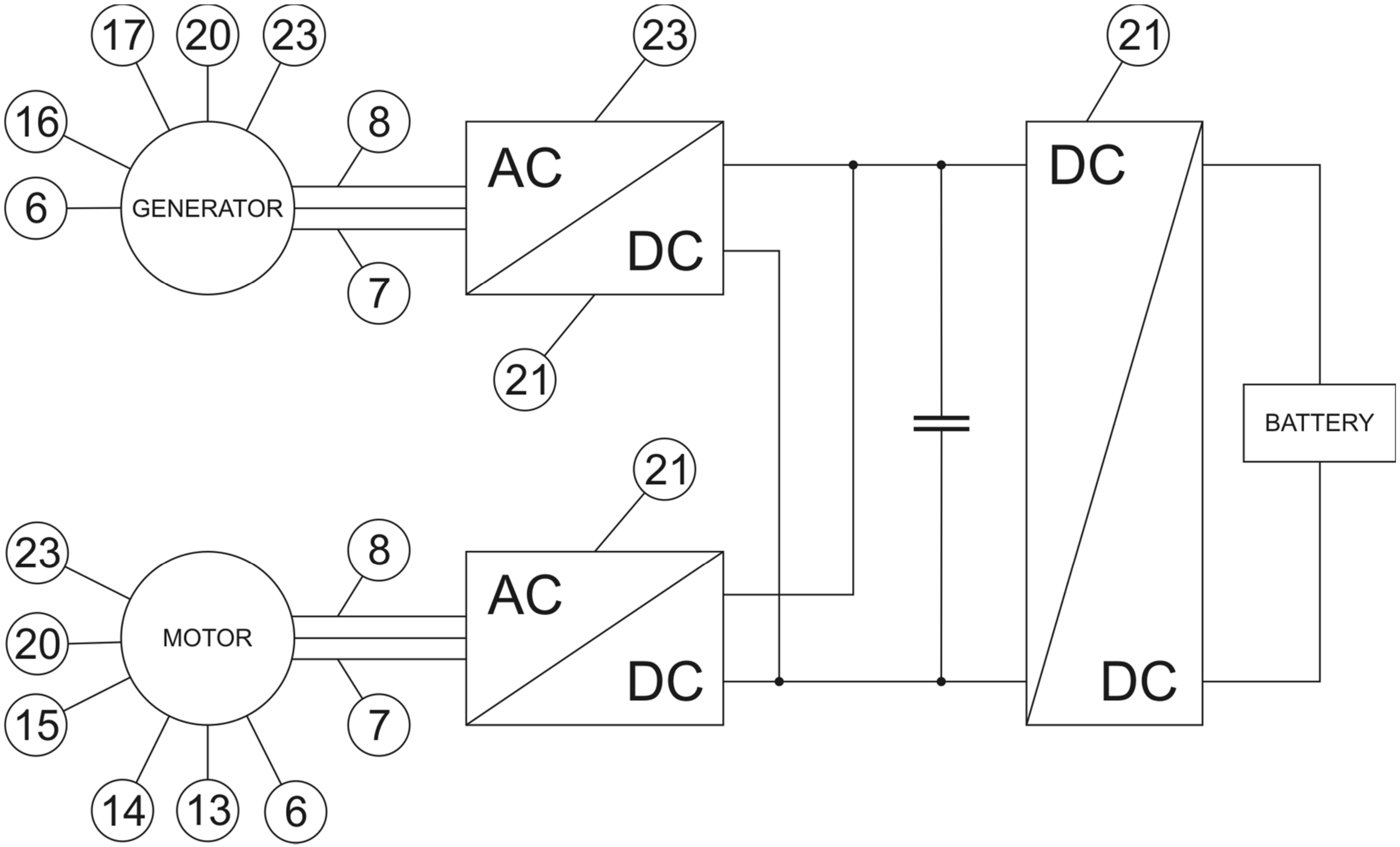
Lokatie / evenement

P.BAUER

February 22, 2013

Delft University of Technology

Three phase circuits



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Single phase generator

FIGURE 8-1 **A single-phase generator with a multiturn coil embedded in two slots. At this instant E_{a1} is maximum (+).**

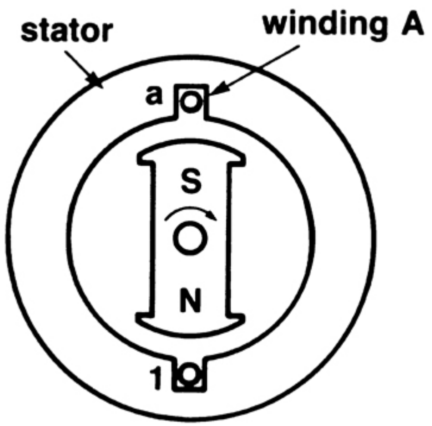
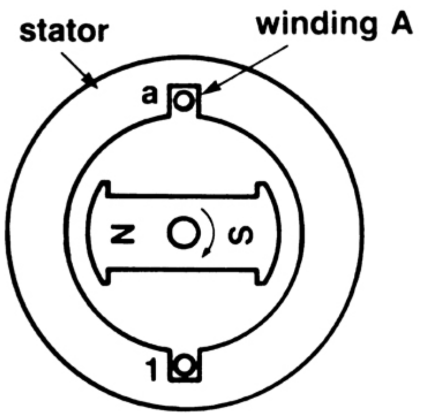
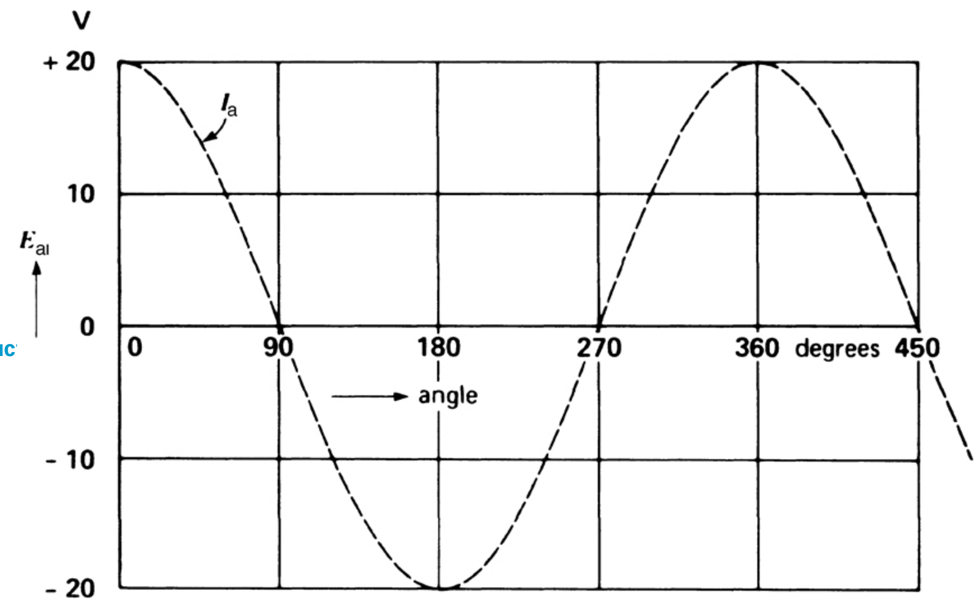


FIGURE 8-2 **At this instant E_{a1} = 0 because the flux does not cut the conduc**



$$E = B\,l\,v$$

FIGURE 8-3 **Voltage induced in winding A.**



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Single Phase Generator

FIGURE 8-4 **Single-phase generator delivering power to a resistor.**

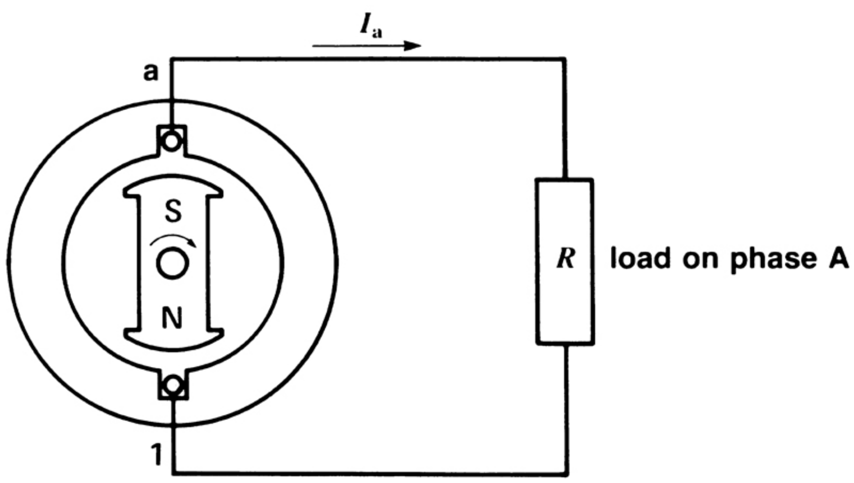
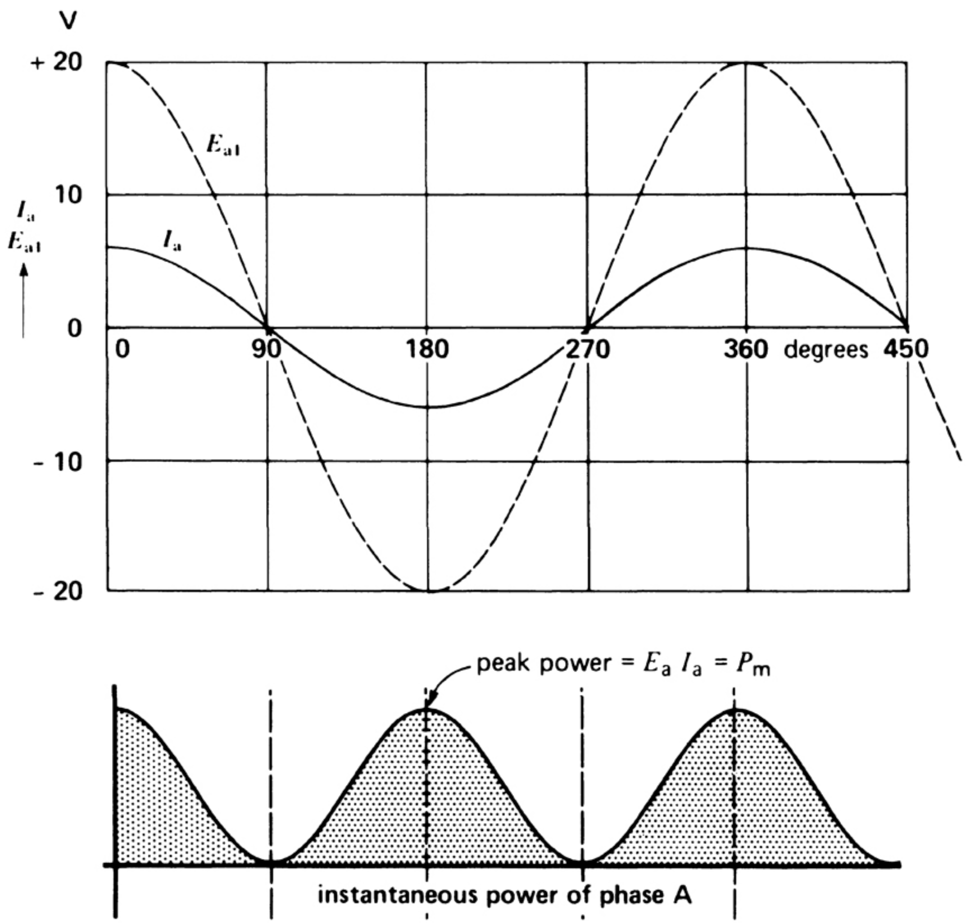


FIGURE 8-5 **Graph of the voltage, current, and power when the generator is under load.**



Two Phase Generator

FIGURE 8-6 **a. Schematic diagram of a 2-phase generator.**
b. Voltages induced in a 2-phase generator. c. Phasor diagram of the induced voltages.

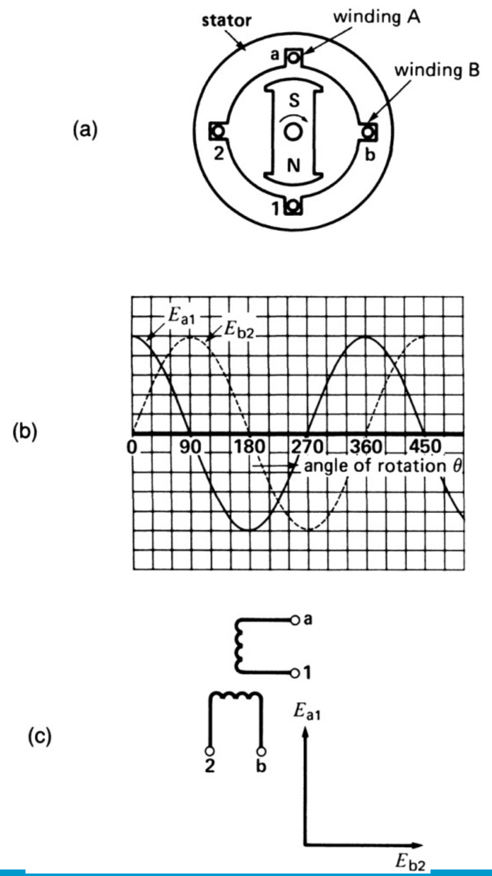
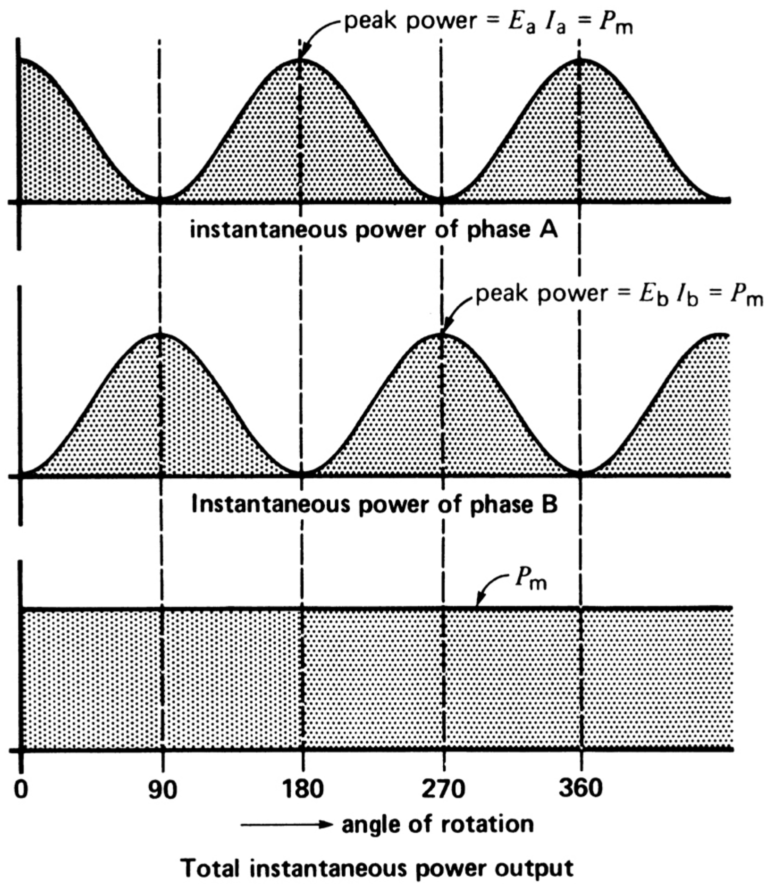


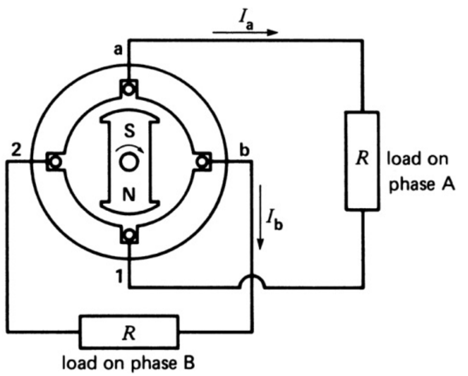
FIGURE 8-8 **Power produced by a 2-phase generator.**



Power Output of Two Phase Generator

FIGURE 8-7 **a. Two-phase generator under load.**
b. Phasor diagram of the voltages and currents.

(a)



(b)

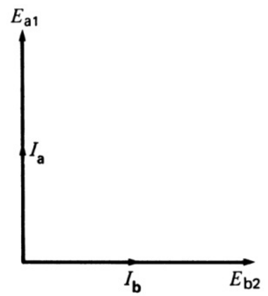
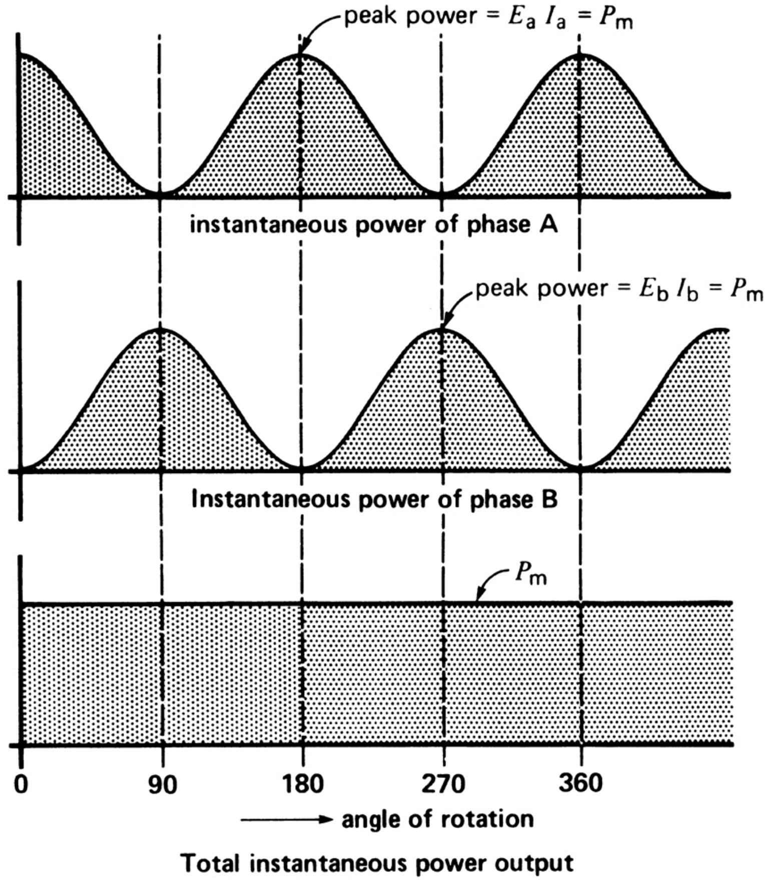


FIGURE 8-8 **Power produced by a 2-phase generator.**



Three Phase Generator

FIGURE 8-9 **a. Three-phase generator.**
b. Voltages induced in a 3-phase generator.
c. Phasor diagram of the induced voltages.

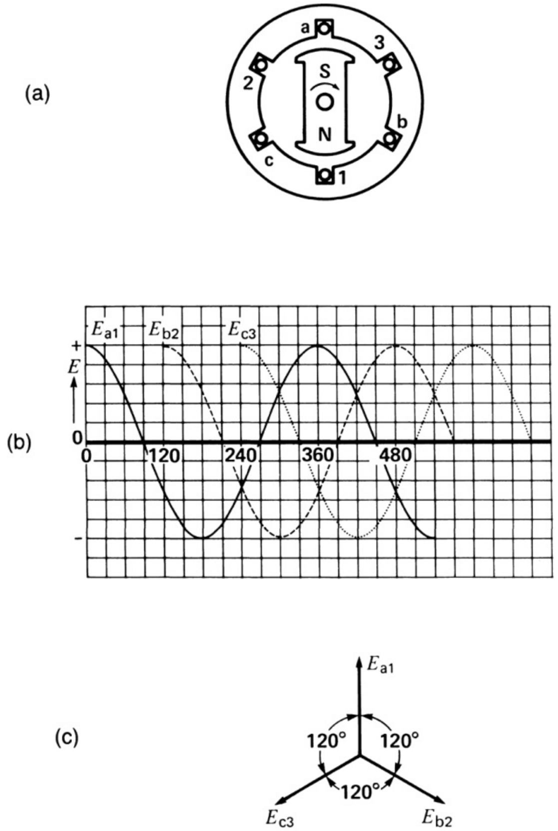
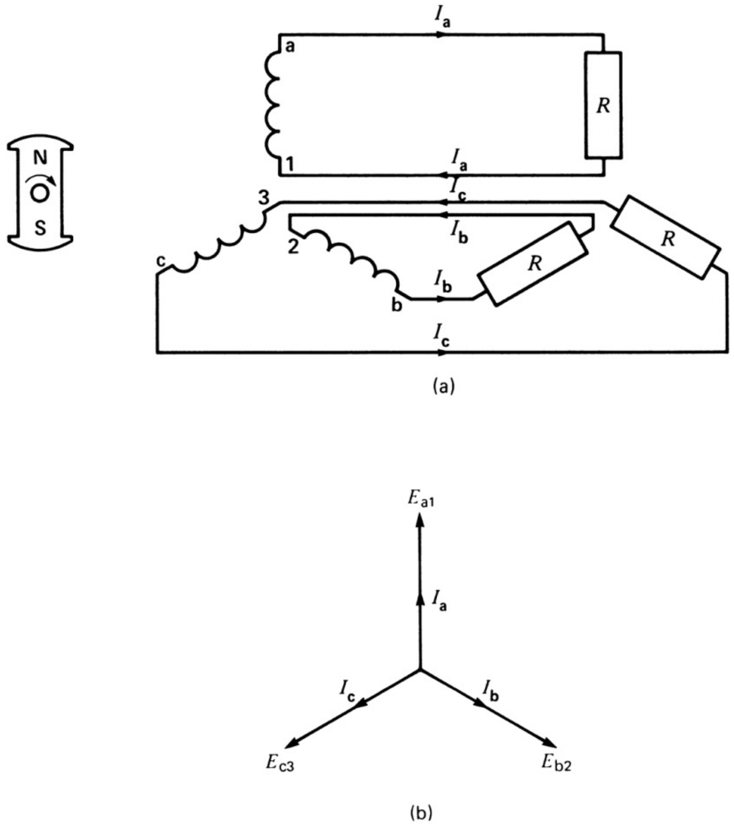


FIGURE 8-10 **a. Three-phase, 6-wire system.**
b. Corresponding phasor diagram.



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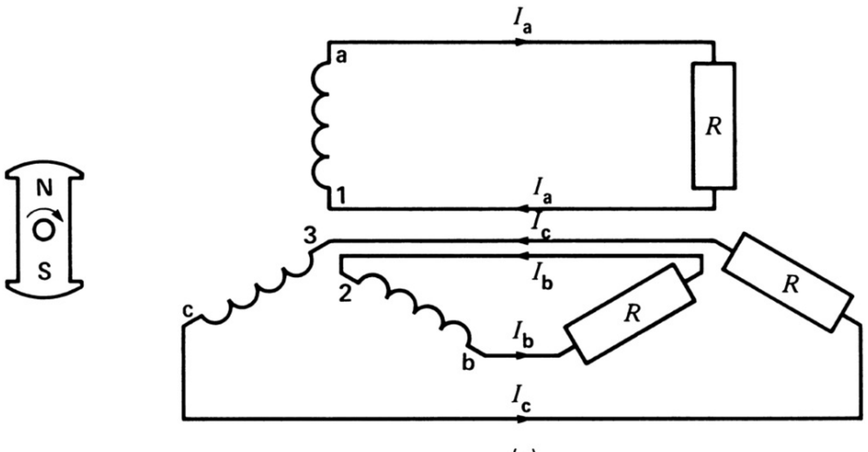
Example 8.2

Three phase generator, 20 ohm load,
Effective voltage induced 120 V
Calculate

a. the power dissipated in R
b. the power in 3 phase load
c. the peak power Pm
d. the total 3 phase power comp.Pm



(a)

- $P = U^2/R = 120^2/20 = 720$ W
- $P_T = 3P = 2160$ W
- $E_m = \text{sqrt}(2)\ E = 169{,}7$
- $I_m = E_m/R = 8{,}485$ A
- $P_m = E_m\ I_m$

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FIGURE 8-11 **a. Three-phase, 4-wire system. b. Line currents in a 3-phase, 4-wire system.**

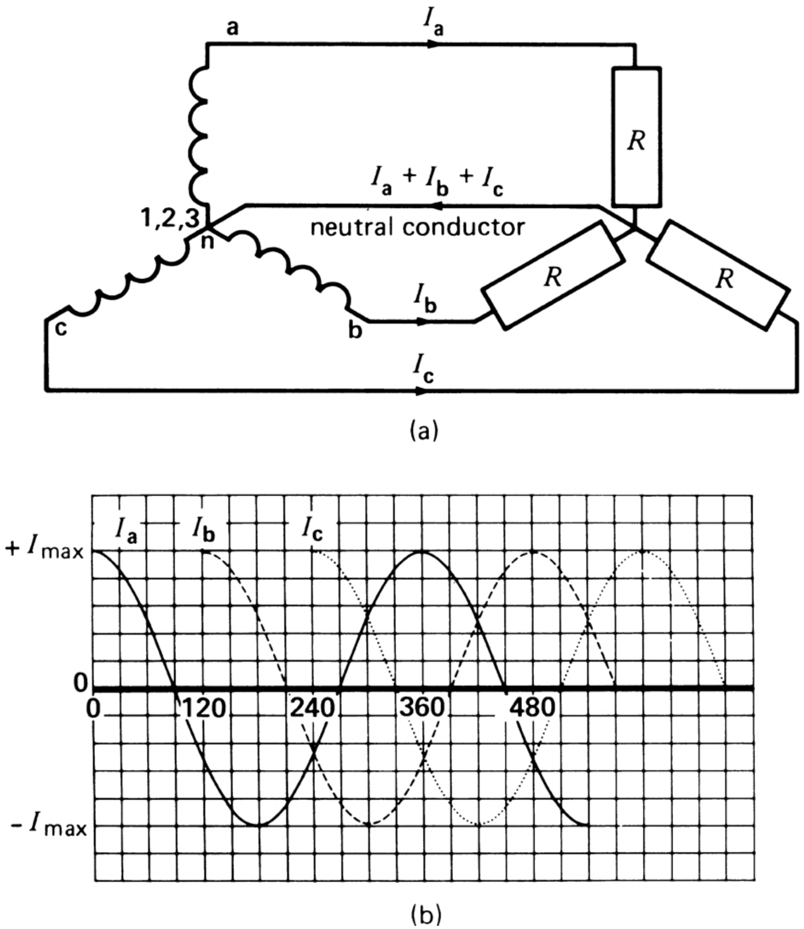
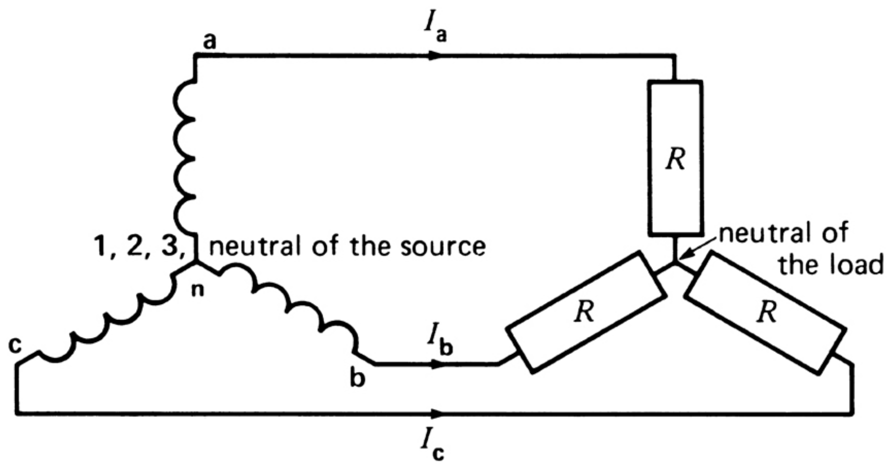


FIGURE 8-12 **Three-phase, 3-wire system showing source and load.**



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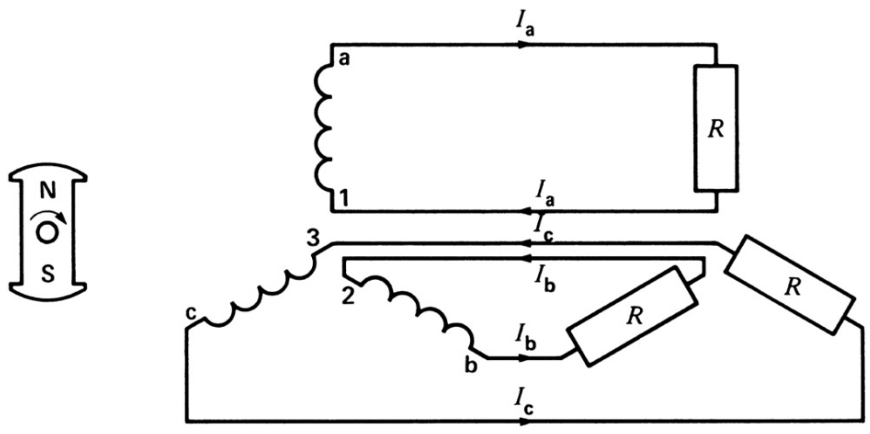
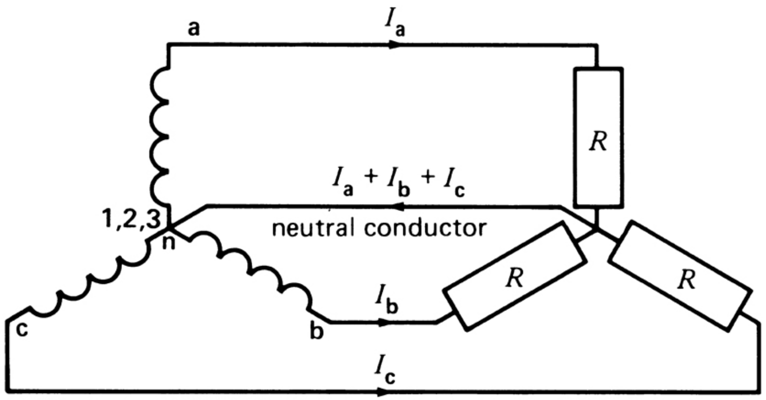

N
S
a
1
2
3
b
c
I_a
I_b
I_c
R

(a)


a
1,2,3
n
b
c
I_a
$I_a + I_b + I_c$
neutral conductor
I_b
I_c
R

(a)

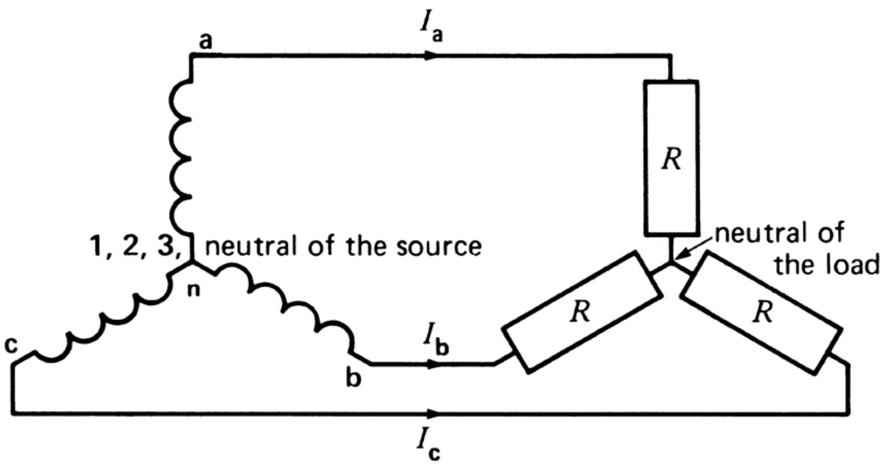
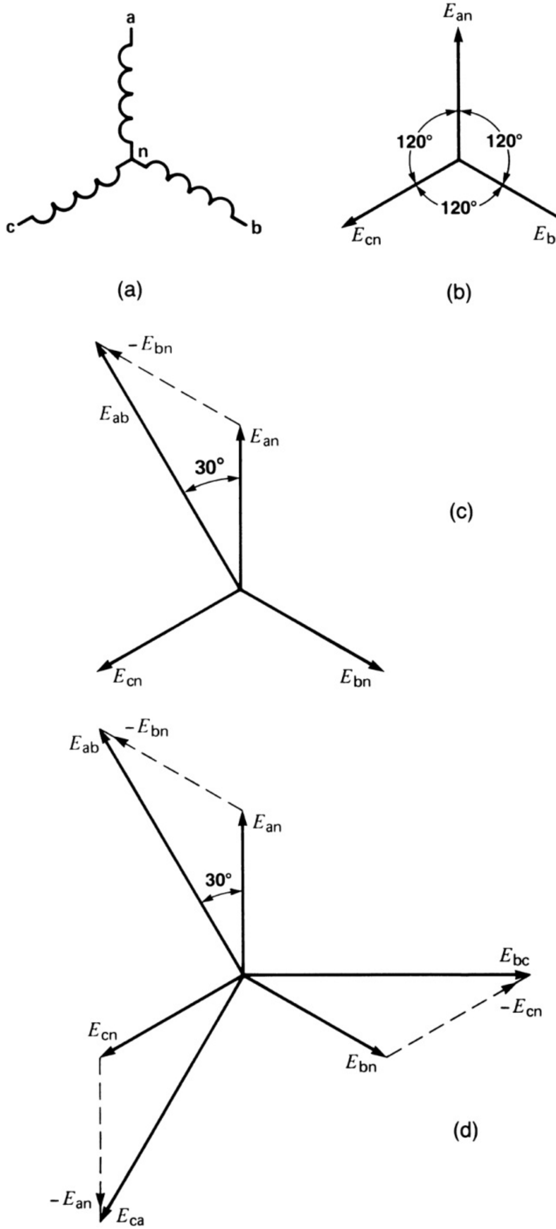
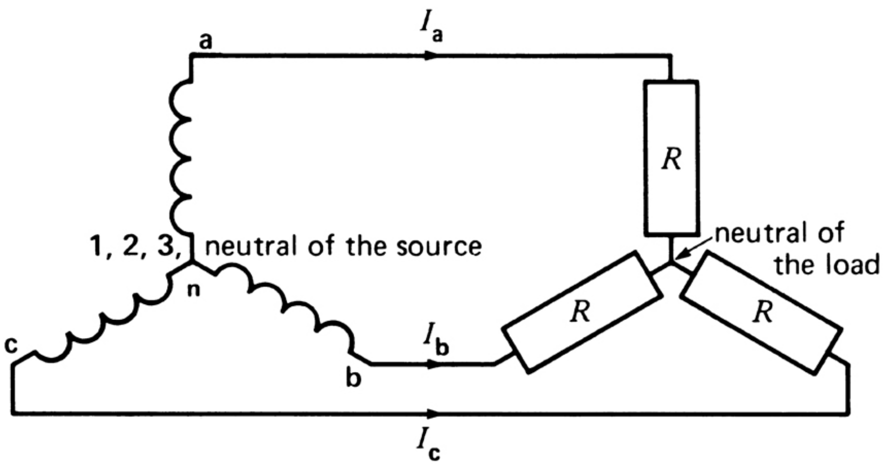

a
1, 2, 3,
n
b
c
neutral of the source
neutral of
the load
I_a
I_b
I_c
R

FIGURE 8-13 **a. Wye-connected stator windings of a 3-phase generator.**
b. Line-to-neutral voltages of the generator.
c. Method to determine line voltage E_{ab}. d. Line voltages E_{ab}, E_{bc}, and E_{ca} are equal and displaced at 120°.

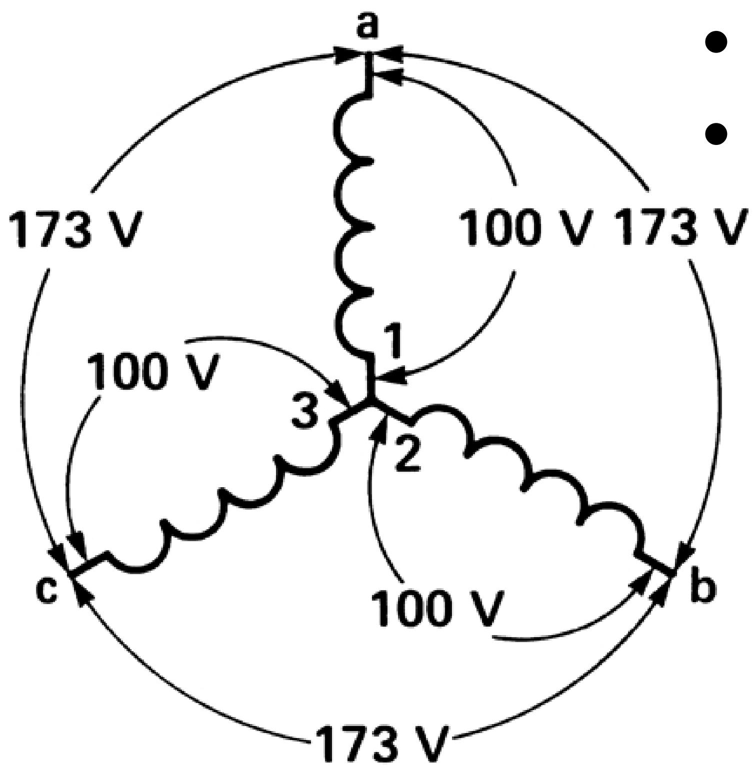


$$E_{AB} = E_{AN} - E_{BN}$$
$$E_{BC} = E_{BN} - E_{CN}$$
$$E_{CA} = E_{CN} - E_{AN}$$

$$E_{AB} = 2\ E_{LN} \cos 30 = \mathrm{sqrt}(3)\ E_{LN}$$



Example 8.3



3 Phase 60 Hz generator 23,9 kV

- Line to neutral voltage
- Time interval between the peak
- Peak value

$E_{LN} = E_L/SQRT(3)$

- T=120/(360.60)=5,55ms
- E_m =SQRT(2) E_L

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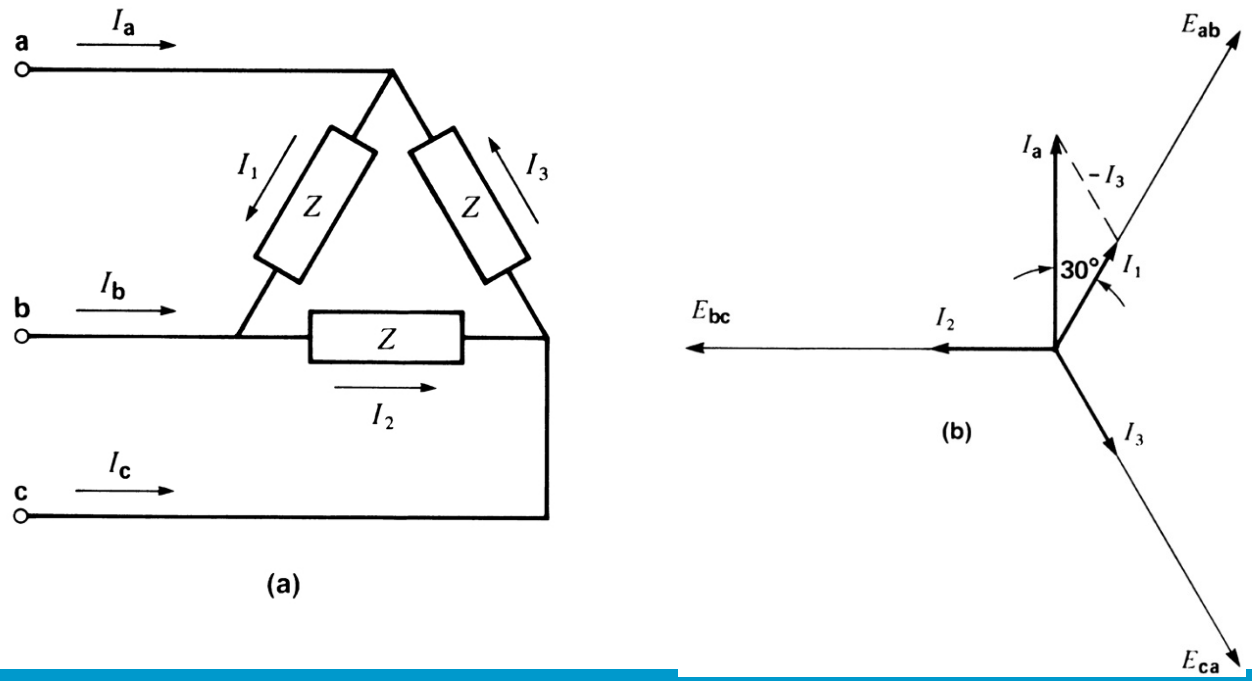
Delta Connection

$$I_a = I_1 - I_3$$
$$I_b = I_2 - I_1$$
$$I_c = I_3 - I_2$$

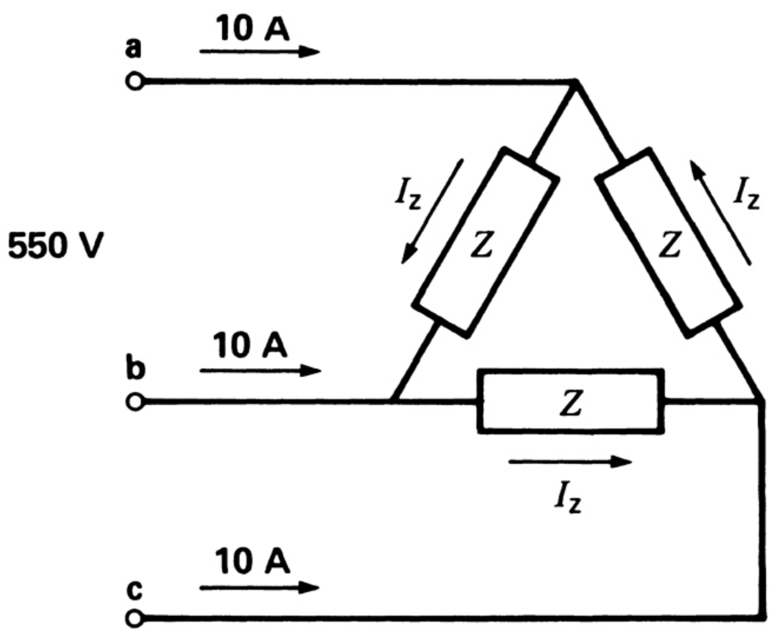
FIGURE 8-15 **a. Impedances connected in delta. b. Phasor relationships with a resistive load.**

$$I_L = 2\, I_Z \cos 30 = \mathrm{sqrt}(3)\, I_Z$$



Example 8.5

FIGURE 8-15c **See Example 8-5.**



$I_z = 10/\ sqrt(3) = 5{,}77A$

$Z = E/\ I_z = 550/5{,}77 = 95$

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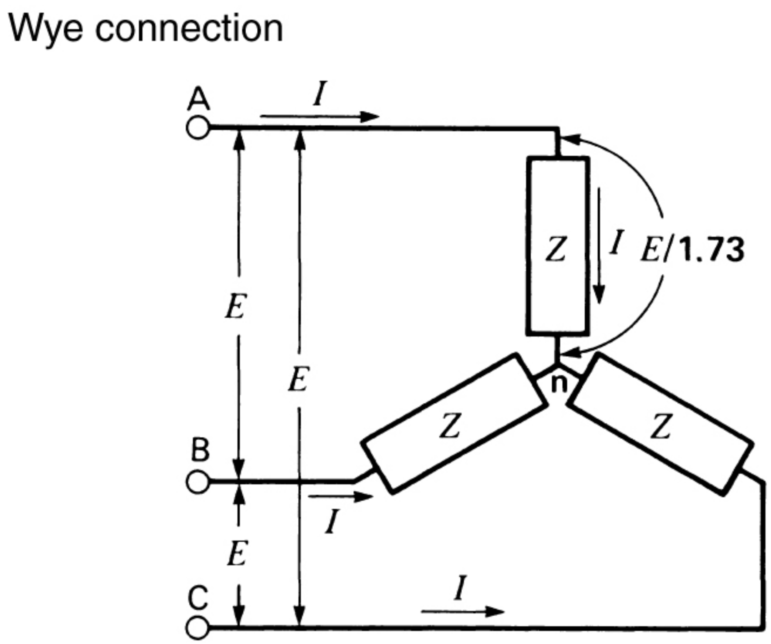
Power transmitted by a 3 phase line

FIGURE 8-16a **Impedances connected in wye.**



Single phase vs three phase

Single phase: EI

Three phase

Each branch

S_Z = E I /SQRT(3)

3 phase

S = 3 E I /SQRT(3)=SQRT(3) EI

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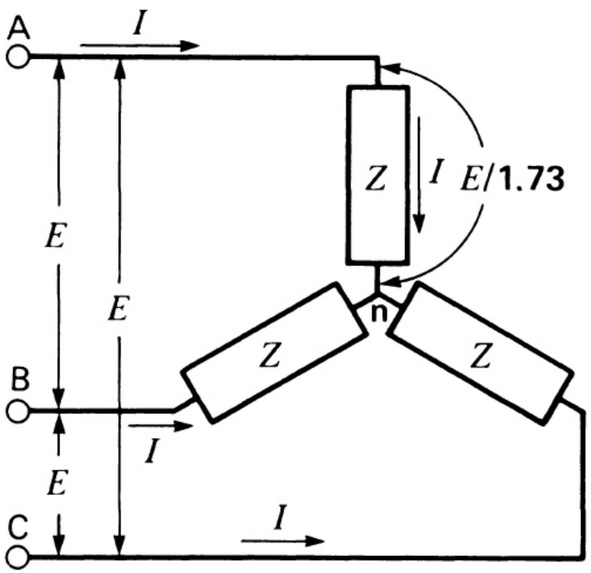
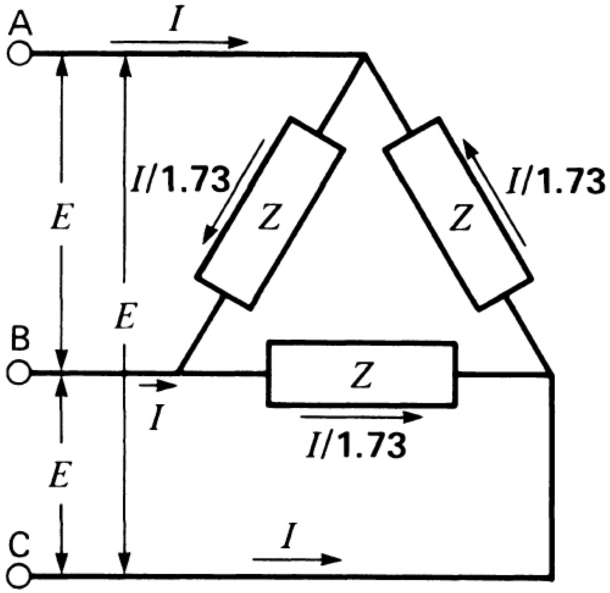
Wye versus Delta

Wye connection



Delta connection



I in each element= I_L

Voltage across E/SQRT(3)

V, I elements 120º

I_L/SQRT(3)

E

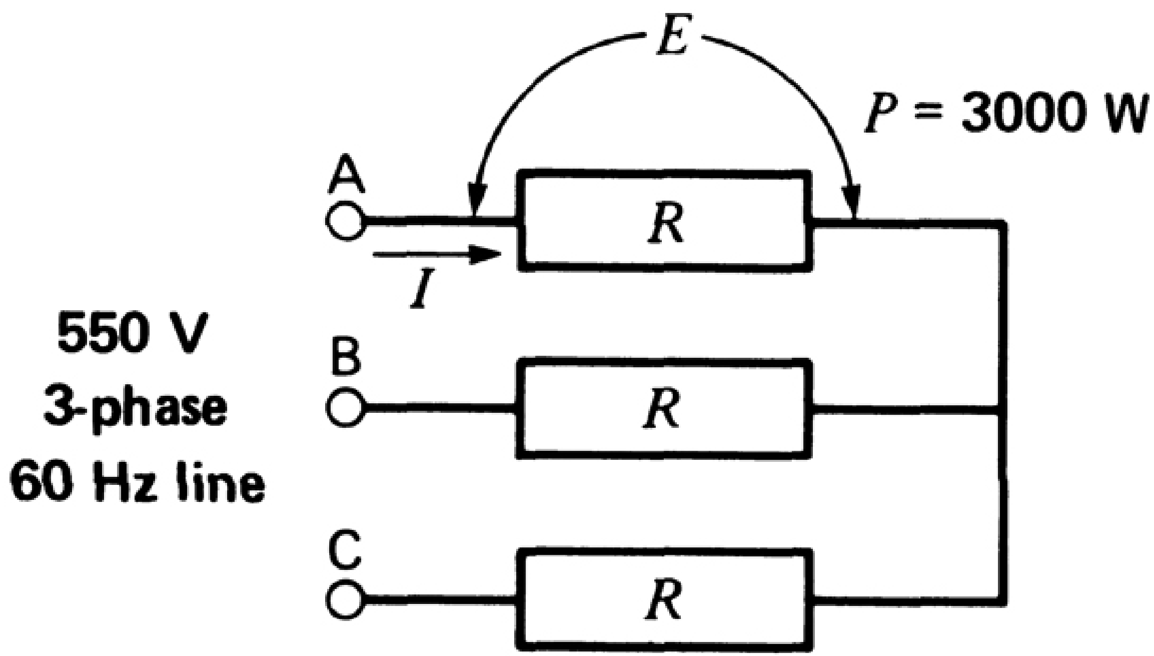
V, I elements 120º

Active reactive and apparent power

- $S = \text{Sqrt}(P^2 + Q^2)$
- $\cos \Phi = P/S$
- S total 3 phase [VA]
- P..
- Q…

FIGURE 8-17 **See Example 8-7.**

Example 8.7



Three identical R, total P 3000 W, 550 V lineC

P= 3000W/3 E= 550V/SQRT(3) I = P/E R = E/I

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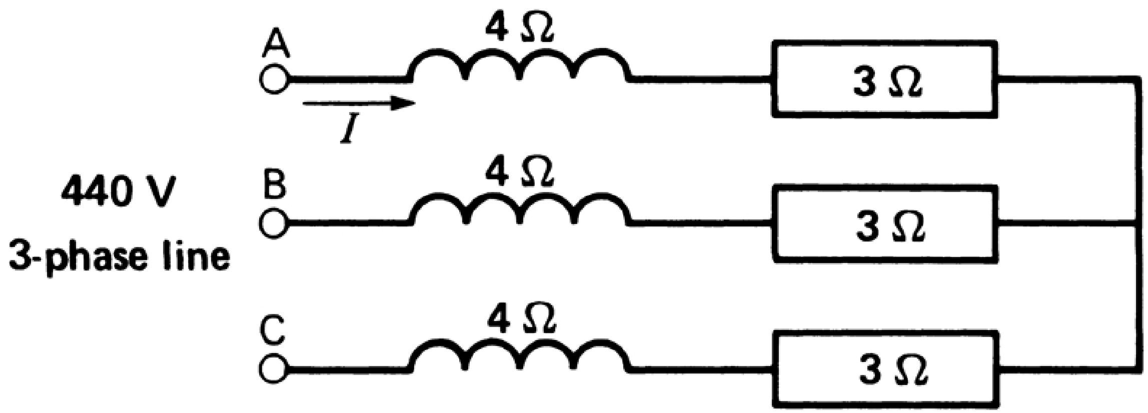
Example 8.8

The current in each line

The voltage across the inductor terminals

FIGURE 8-18 **See Example 8-8.**

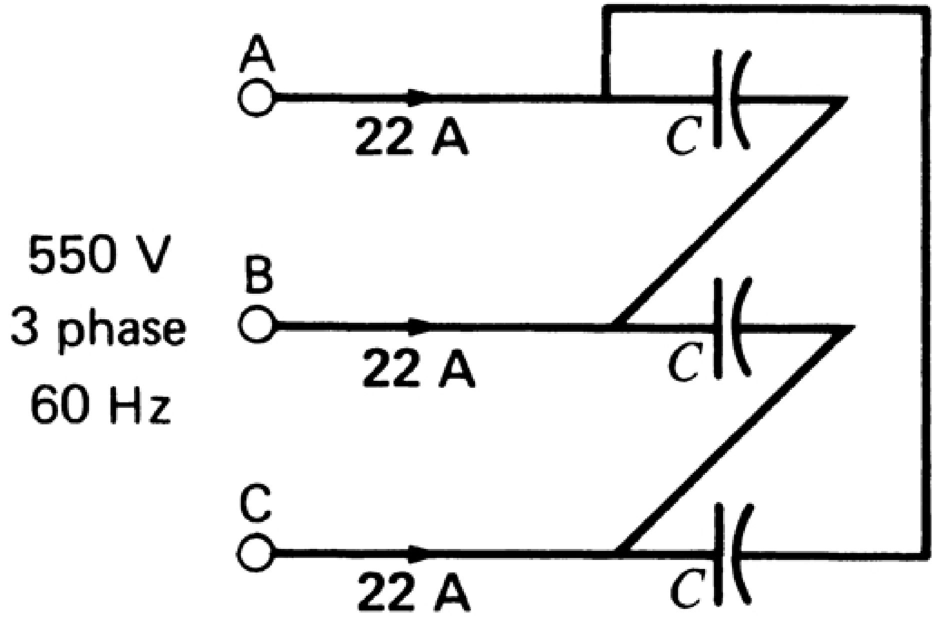


Current in each line, voltage across inductor

$Z=\ldots$ $E_{LN}=$,,, $I = \ldots.$ $E = \ldots$

Example 8.9

FIGURE 8-19 **See Example 8-9.**



Calculate capacitance

FIGURE 8-20 **a. Power input to a factory. See Example 8-10. b. Equivalent wye connection of the factory load. c. Phasor diagram of the voltages and currents.**

Example 8.10

415 kVA,
2400V, pf

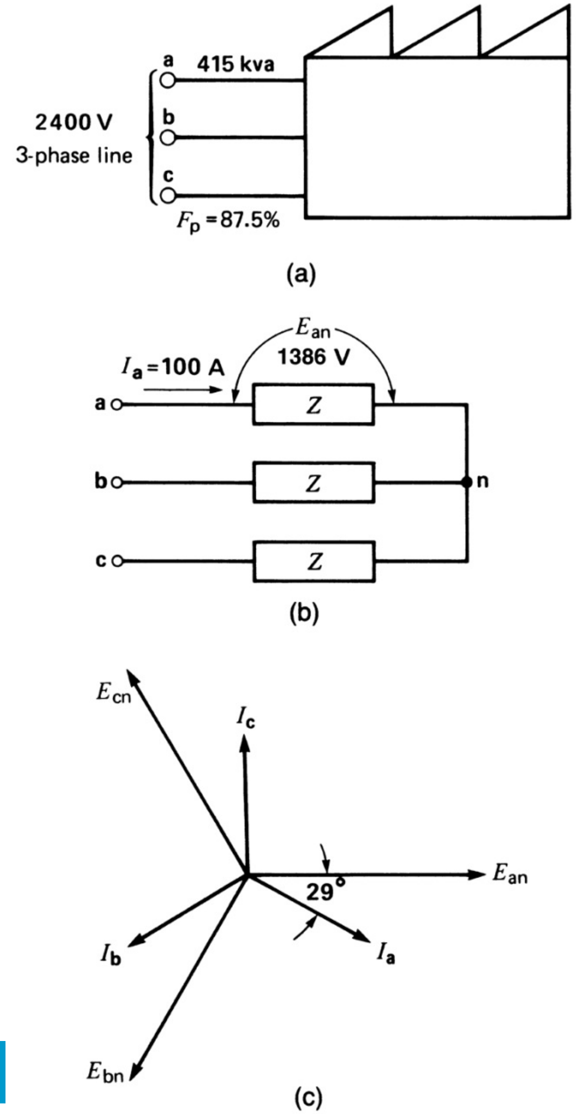


FIGURE 8-21 **Industrial motor and capacitor. See Example 8-11.**

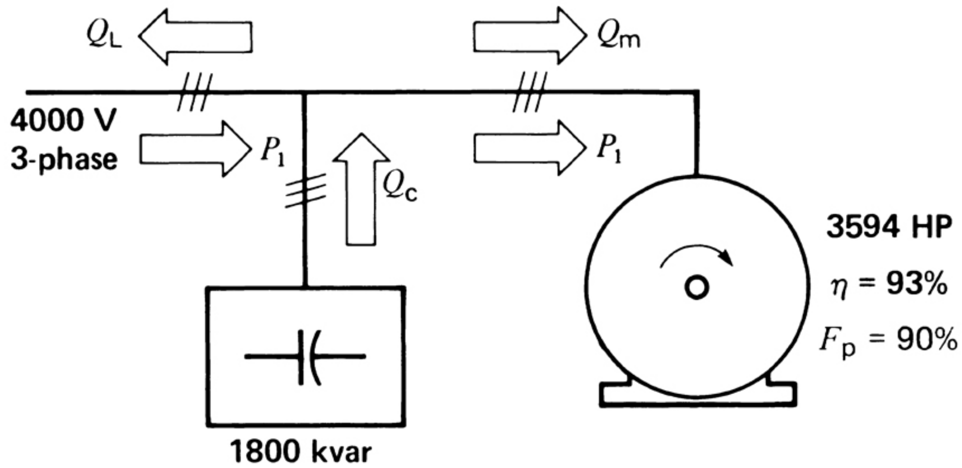


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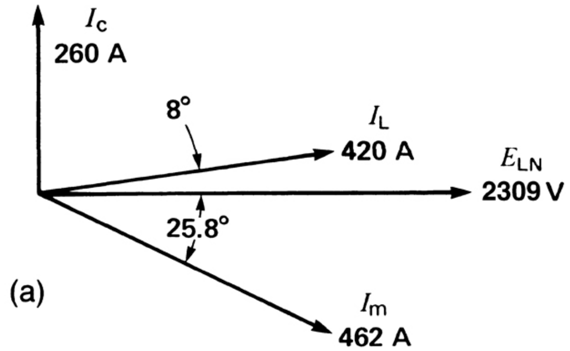
FIGURE 8-22 **a. Phasor relationships for one phase. See Example 8-11. b. Line currents. Note that the motor currents exceed the currents of the source.**



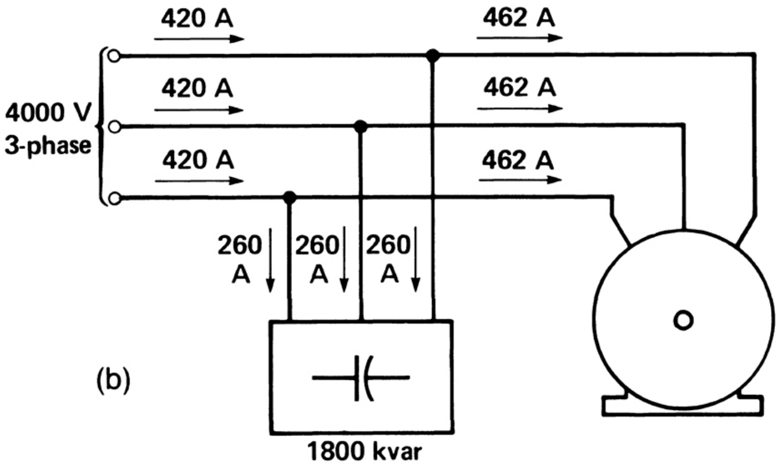


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FIGURE 8-23 **The letters are observed in the sequence a-b-c.**

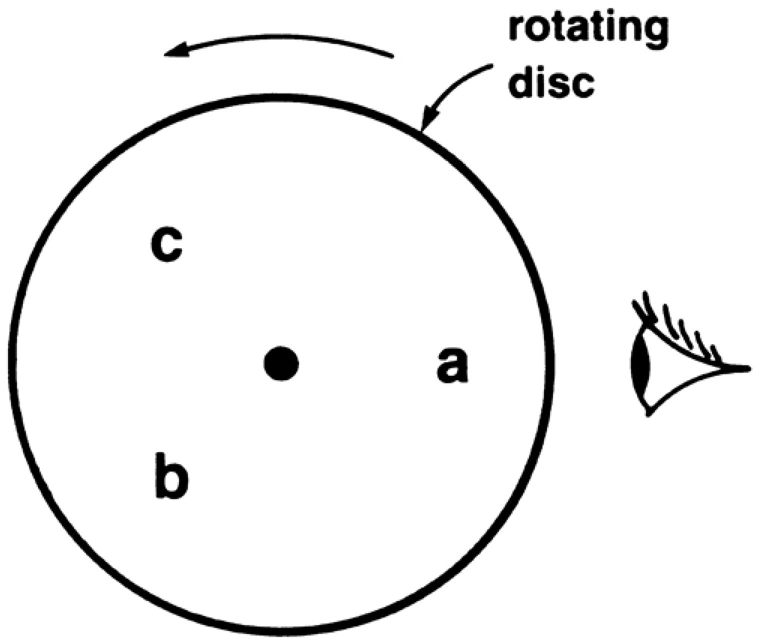

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FIGURE 8-24 **The letters are observed in the sequence a-c-b.**

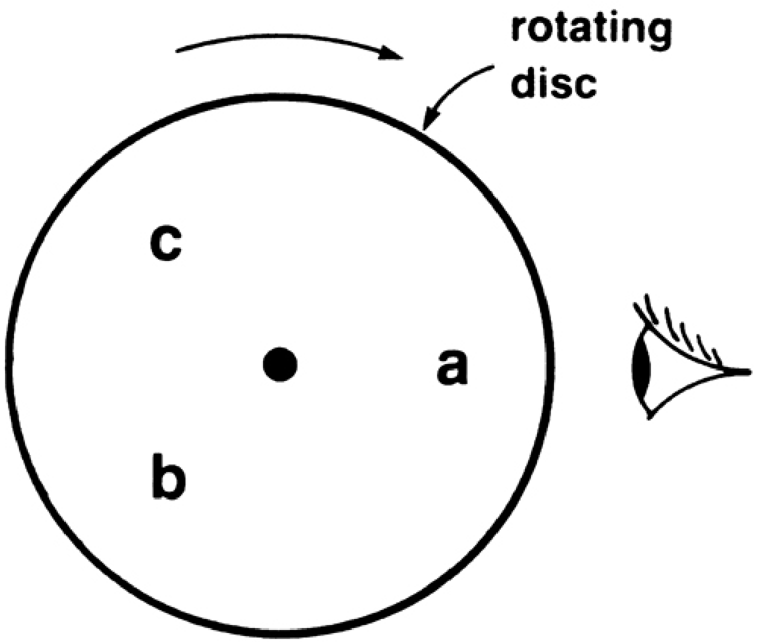

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FIGURE 8-25 **The letters are observed in the sequence a-c-b.**

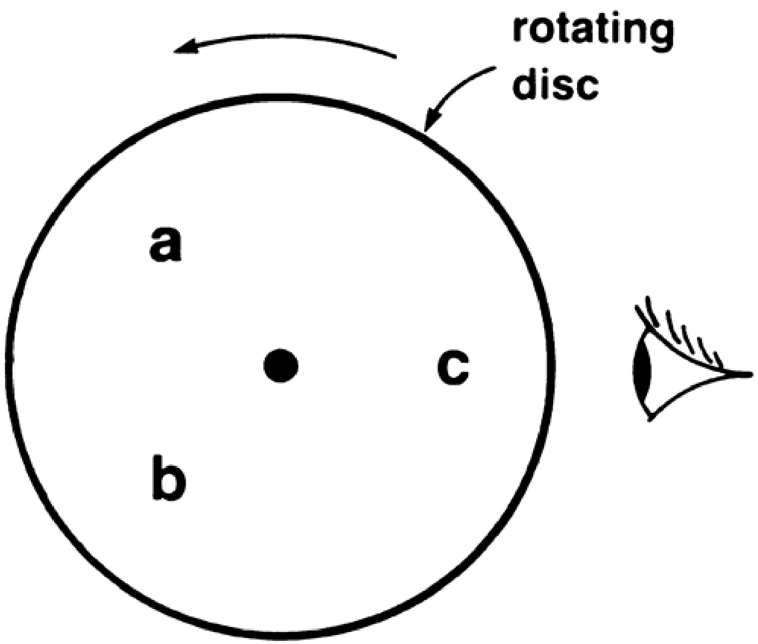

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FIGURE 8-26 **a. Determining the phase sequence of a 3-phase source. b. Phase sequence depends upon the order in which the line voltages reach their positive peaks.**

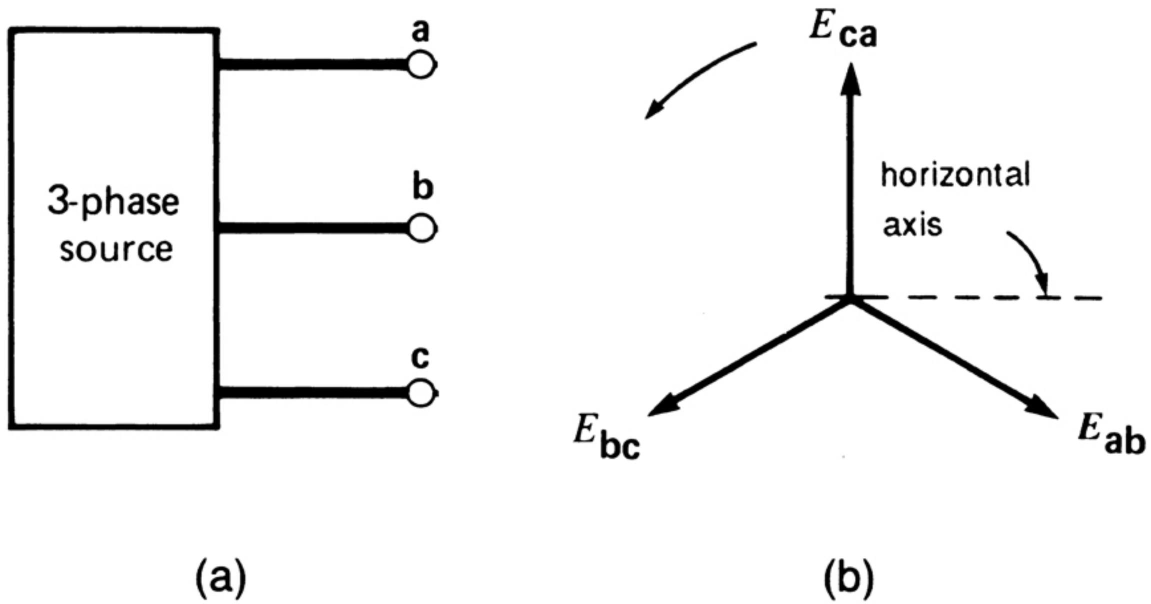

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FIGURE 8-27 **See Problem 8-12.**

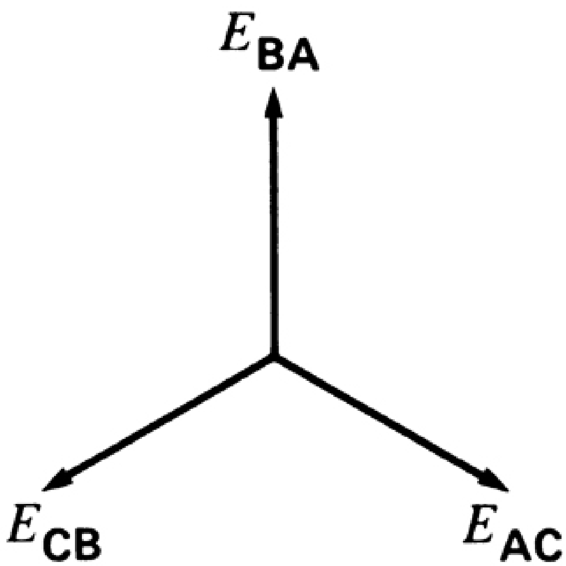

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FIGURE 8-28 **a. Determining phase sequence using two lamps and a capacitor. b. Resulting phasor diagram.**

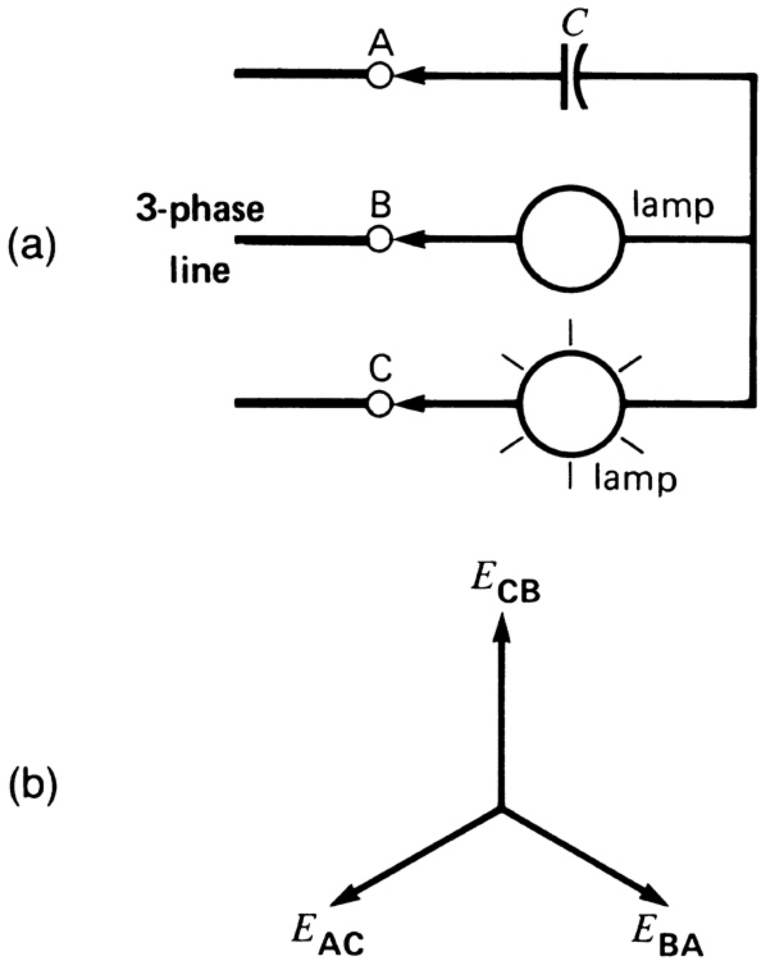


FIGURE 8-33 **A single-phase resistive load can be transformed into a balanced 3-phase load.**

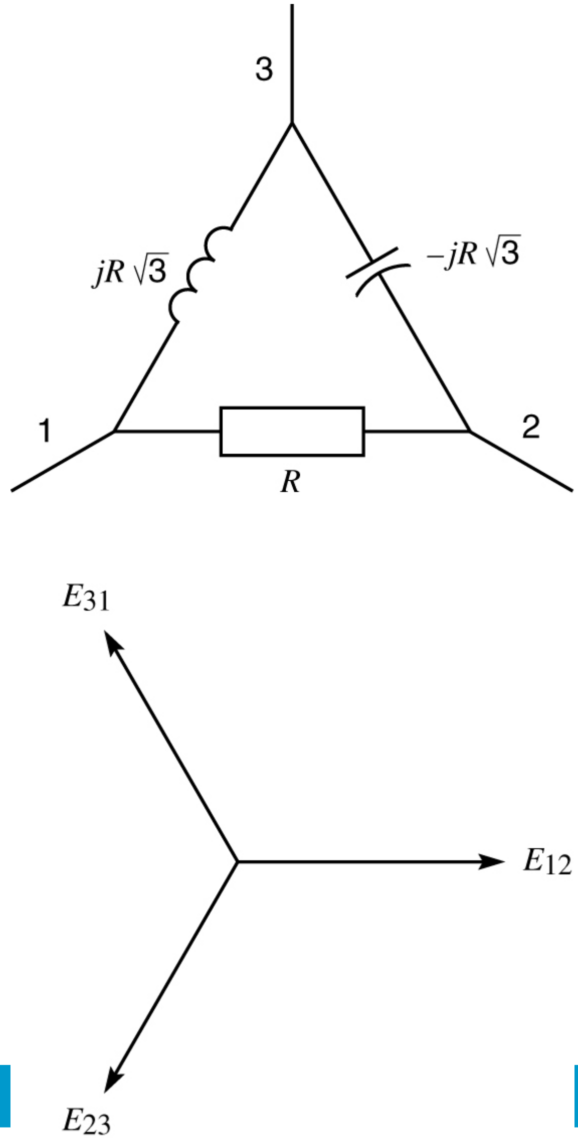


FIGURE 8-34 **See Problem 8-14.**

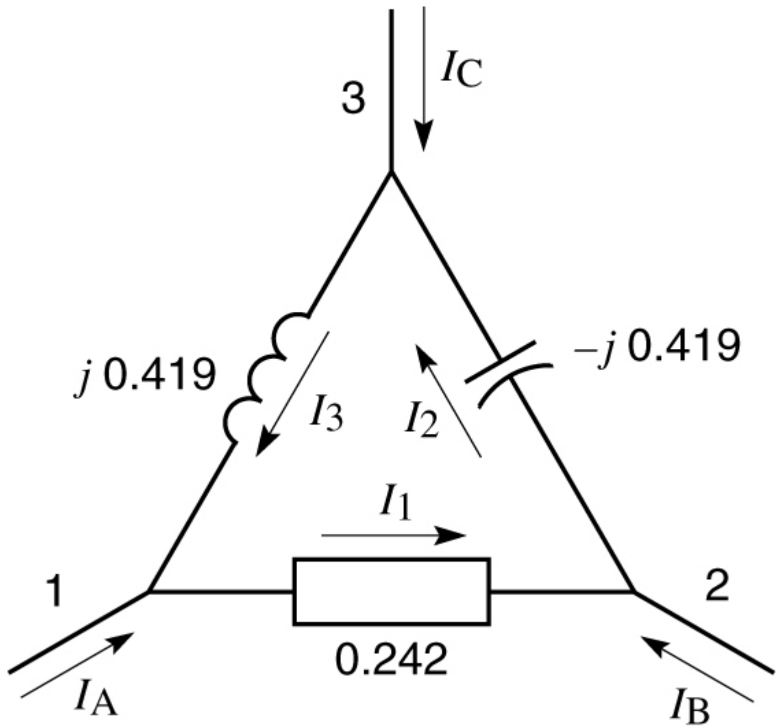
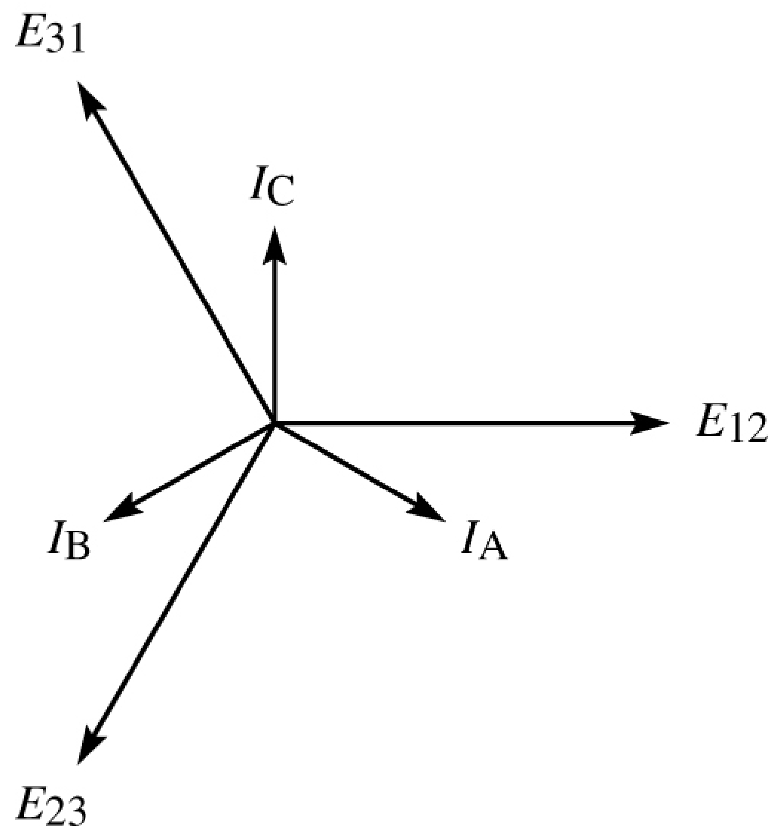


FIGURE 8-35 **See Problem 8-14.**



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