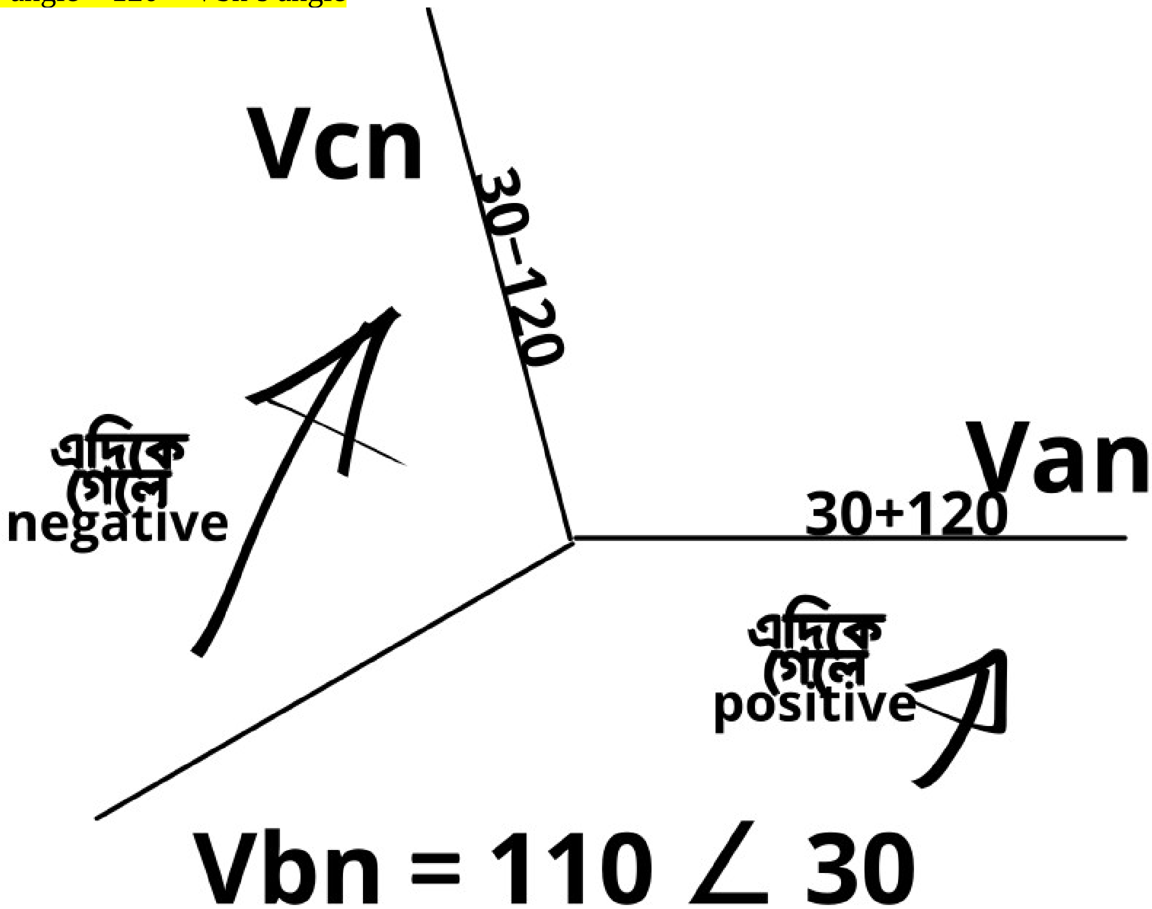
EEE | Practice problems (3-phase)

12.1 Given that $V_{bn} = 110 \angle 30$, find V_{an} and V_{cn}, assuming a positive (abc) sequence.

Van’s angle – 120 = Vbn’s angle



12.2 A Y-connected balanced three-phase generator with an impedance of 0.4 + j0.3 ohm per phase is connected to a Y-connected balanced load with an impedance of 24 + j19 ohm per phase. The line joining the generator and the load has an impedance of 0.6 + j0.7 ohm per phase. Assuming a positive sequence for the source voltages and that $V_{an} = 120\angle 30$ V, find: (a) the line voltages, (b) the line currents.

Line voltages = **sqrt(3) x phase voltage** + phase shift by ∠30

(a) for Vab (line vol) = sqrt(3) x 120 ∠(30+30) = 207.85∠60

অনুরূপভাবে, Vbc = 207.85∠(60-120)

Vca = 207.85∠(60-(2x120)) অথবা, 207.85∠(60+120)

^ (বই এ এভাবে করা আছে যদিও)

Line current = Phase current =

$$I_{ab} = \frac{V_{ab}}{0.4+j0.3+24+j19+0.6+j0.7} = \frac{120 \angle 30}{0.4+j0.3+24+j19+0.6+j0.7} = 3.7 \angle -8.66\,A$$

Likewise, $I_{bc} = 3.7 \angle -128.66$, $I_{ca} = 3.7 \angle 111.34$

12.3 One line voltage of a balanced Y-connected source is V_{AB} = 240l∠20 V. If the source is connected to a dell-connected load of 20∠40 ohm, find the phase and line currents. Assume the abc sequence.

Phase current,

$$I_{ab} = \frac{240 \angle -20}{20 \angle 40} = 12 \angle -60$$

$$I_{BC} = 12 \angle (-60-120) = 12 \angle -180$$

$$I_{CA} = 12 \angle (-60+120) = 12 \angle 60$$

Line currents,

I_a = sqrt(3) x I_{ab} x ∠(-30) = sqrt(3) x 12 ∠(-60-30) = 20.78 ∠ -90 A

I_b = 20.78 ∠-210

I_c = 20.78 ∠ 30

12.4 A positive-sequence, balanced delta-connected source supplies a balanced delta-connected load. If the impedance per phase of the load is 18+ j12 ohm and I_a = 19.202∠35 A, find I_{AB} and V_{AB}.

$I_{AB} = \frac{19.202}{\sqrt{(3)}} \angle 35+30 = 11.086 \angle 65$ A (Line → Phase)

$V_{AB} = I_{AB} \times Z_{\Delta} = (11.086 \angle 65) \times (18 + j12) = 239.827 \angle 98.69$

12.5 In a balanced Dell-Y circuit, $V_{ab} = 240\angle 15$ and $Z_Y = (12 + j15)$ ohm. Calculate the line currents.

$V_{an} = \frac{V_{ab}}{\sqrt{3}} \angle -30 = \frac{240}{\sqrt{3}} \angle (15-30) = 138.56 \angle -15$

$I_a = \frac{V_{an}}{Z_Y} = \frac{138.56 \angle -15}{12 + j15} = 7.21 \angle -66.34$

$I_b = 7.21 \angle (-66.34-120)$

$I_c = 7.21 \angle (-66.34+120)$

12.6 For the Y-Y circuit in Practice Prob. 12.2, calculate the complex power at the source and at the load.

At the source,

$S_s = -3\ V_p I_p^* = -3 \times 120\angle 30 \times 3.75\angle 8.66 = -1054.17007-843.34j$ VA

$S_l = 3 \times |I_p|^2 \times V_l = 3 \times 3.75^2 \times (24+j19) = 1012.5 + j801.56$

12.7 Calculate the line current required for a 30-kW three-phase motor having a power factor of 0.85 lagging if it is connected to a balanced source with a line voltage of 440 V.

$P = S \cos\theta$

or, $S = 30k / 0.85 = 35294.12$ W

And, $S = \text{sqrt}(3) \times V_L \times I_L$

or, $I_L = \frac{S}{\sqrt{3} V_L} = \frac{35294.12}{\sqrt{3} \times 440} = 46.31A$

12.8 Skipped

12.9 The unbalanced ¢-load of Fig. 12.24 is supplied by balanced line-to-line voltages of 240 V in the positive sequence. Find the line currents. Take Vab as reference.

Phase current,

$$I_{AB}=\frac{V_{AB}}{10-5j}=\frac{240\angle 0}{10-5j}=21.46\angle 26.56$$

$$I_{BC}=\frac{240\angle -120}{16j}=15\angle -120$$

$$I_{CA}=\frac{240\angle 120}{8+6j}=24\angle 83.13$$

Line current,

$$I_a=I_{AB}-I_{CA}=21.46\angle 26.56-24\angle 83.13$$
$$¿21.66\angle -41.08\,A$$

$$I_b=I_{BC}-I_{AB}=15\angle -120-21.46\angle 26.56 = 34.88\angle -140.36\text{ A}$$

$$I_c=I_{CA}-I_{BC}=24\angle 83.13-15\angle -120 = 38.25\angle 74.27\text{ A}$$

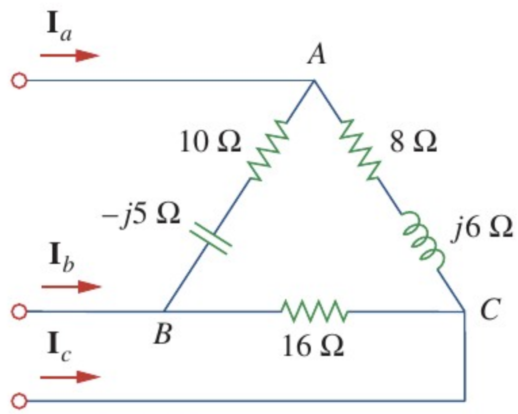


Figure 12.24
Unbalanced Δ-load; for Practice Prob. 12.9.