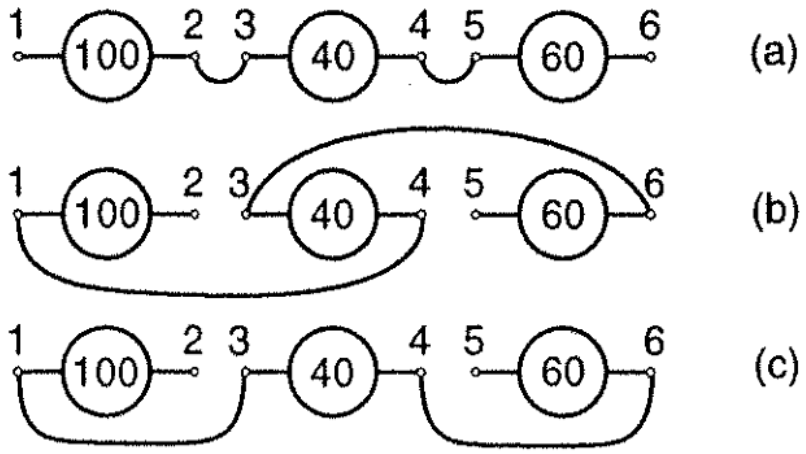
2-1

2-2



a. $E_{16} = E_{12} + E_{23} + E_{34} + E_{45} + E_{56}$

$= (-100) + 0 + (-40) + 0 + (+60) = -80$ V

$\therefore$ terminal 1 is negative with respect to term 6

2-2 b. $E_{25} = E_{21} + E_{43} + E_{65}$

$= (+100) + (+40) + (-60) = +80$

$\therefore E_{25} = +80$ and so terminal 2 is (+)

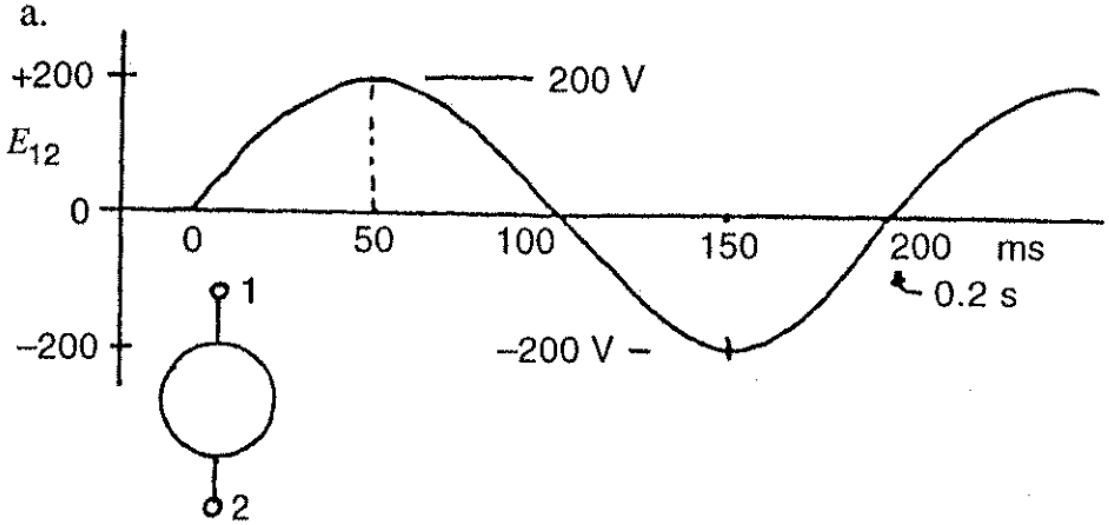
with respect to terminal 5

c. $E_{52} = E_{56} + E_{43} + E_{12}$

$= (+60) + (+40) + (-100) = 0$

There is no voltage between terminals 5 and 2

2-10 a.



b. $E_{12} = E_m \sin \phi = E_m \sin 360 \text{ ft}$

$= 200 \sin 360 \times 5\, t = 200 \sin 1800\, t$

at $t = 5$ ms $E_{12} = 200 \sin 1800 \times 0.005$

$= 200 \sin 9° = 31.3$ V

at $t = 75$ ms $E_{12} = 200 \sin 1800 \times 0.075$

$= 200 \sin 135° = 141$ V

at $t = 150$ ms $E_{12} = -200$ V, by inspection

2-15 a. I_1 lags behind I_3 by 60°

b. I_3 lags behind I_2 by 90°

c. E lags behind I_1 by 150°

2-26 (a) $E_{21} + 20\,I_1 = 0$ and $E_{21} - 100\angle 0°$

$I_3 = I_1 + I_2$ $\quad E_{21} + I_2\,(50\,\mathrm{j}) = 0$

(b) $+E_A + 20\,I_1 = 0$ and $E_A = 120\angle 30°$

$+E_A + I_2\,(-30\,\mathrm{j}) = 0$ $\quad I_3 = I_1 + I_2$

(c) $E_{21} + 20\,I_1 = 0$ and $E_{12} = 120\angle -60°$

$E_{21} - I_2\,(-30\,\mathrm{j}) = 0$ $\quad I_1 = I_3 + I_2$

(d) $E_{ba} - 20\,I_1 = 0$ and $E_{ba} = -10\angle 30°$

$E_{ba} + 60\,\mathrm{j}\,I_2 = 0$ $\quad -E_A = -20\angle 45°$

$E_{ba} - E_A - I_3\,(-30\,\mathrm{j}) = 0$ $\quad I_4 + I_1 + I_3 = I_2$

(e) $E_{ab} + 7\,I + I\,(-24\,\mathrm{j}) = 0$

$E_{ac} + I\,(-24\,\mathrm{j}) = 0$

$E_{bc} - 7\,I = 0$ and $E_{ab} = -100\angle 0°$

2-26 (f) $E_{21} + E_B - I\,(40\,\mathrm{j}) - I\,(-45\,\mathrm{j}) = 0$

$E_{13} + 40\,\mathrm{j}\,I - E_B = 0$ and $E_{21} = -30\angle -30°$

$E_{23} - I\,(-45\,\mathrm{j}) = 0$

Note that Figs. 2.65 (d) and (f) use sign notation and double subscript notation in the same circuit. This is unusual, but it does show that both notations can be used in the same circuit. See also (g) below.

(g) $-E_3 + 40\,\mathrm{j}\,I_3 + E_{32} = 0$

$-E_3 + E_{12} = 0$ $\leftarrow$*

$E_{23} - 30\,I_2 = 0$

$E_{23} + 40\,\mathrm{j}\,I_1 = 0$

$I_2 + I_3 = I_1$

* In this equation, we move upward across E_3 and then downward from 1 to 2 to close the loop. As a result, E_3 carries a minus sign because it is the terminal we first meet when moving upward.

7-11 a. *A* <u>looks</u> like a power source because current flows out of the positive terminal. This is confirmed by the fact that the phasor diagram shows *E* and *I* in phase. *A* is therefore an active power source.

b. *D* <u>looks</u> like a power source (*I* flows out of (+) terminal). However *I* is 180° out of phase with *E*. ∴ *C* is the active power source.

c. *G* <u>looks</u> like a power source (*I* flows out of (+) terminal). It is <u>not</u> a reactive power source because *I* <u>leads</u> *E*.

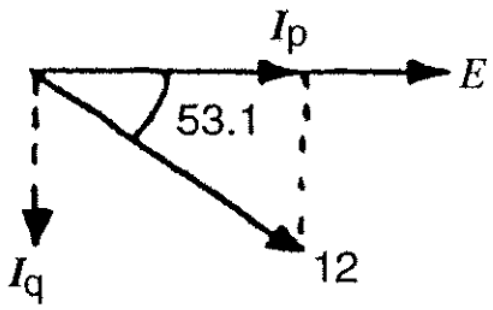
It is sometimes easier to look at the element which looks as if it is the load – in this case divice *F*. It is not an inductive load, because the current leads the voltage. Hence *F* must be an inductive source. We shall use this reasoning in the next three examples.

d. *H* <u>appears</u> to be the load. It would be inductive because *E* and *I* are 90° out of phase. It <u>is</u> the load because *I* lags behind *E*. Consequently, *I* is the reactive source.

e. *L* <u>appears</u> to be the load. It is not the load because *E* and *I* are 180° out of phase. ∴ *L* is the reactive source.

f. *N* appears to be the load. It <u>is</u> the load because *I* lags 90° behaind *E*. ∴*M* is a reactive source.

7-12



arc cos θ = arc cos 0.6 = 53.1°

$I_p = 12 \cos 53.1 = 7.2$ A

$I_q = 12 \sin 53.1 = 9.6$ A

also $I_q = \sqrt{12^2 - 7.2^2} = 9.6$ A

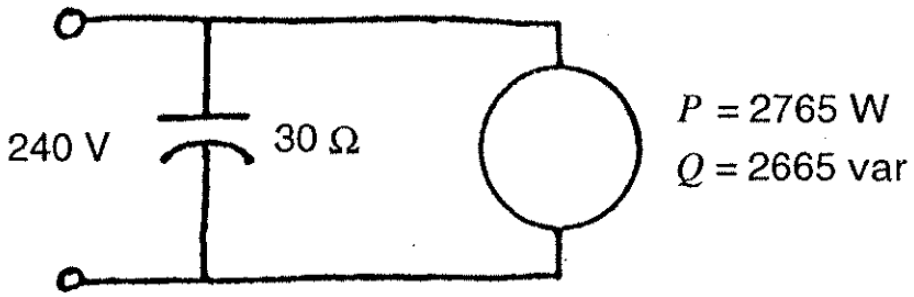
7-13 $P = 2765$ W

$\cos\theta = 2765/3840 = 0.72$

$S = 240 \times 16 = 3840$ VA

$Q = \sqrt{3840^2 - 2765^2} = 2665$ var

7-14



a. 2765 W

b. $Q_c = 240^2/30 = 1920$ var

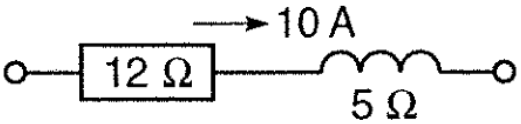
$Q_L = (2665 - 1920) = 745$ var

c. $S = \sqrt{2765^2 - 745^2} = 2864$ VA

d. $I = S/E = 2864/240 = 11.9$ A

e. $\cos\theta = P/S = 2765/2864 = 0.965 = 96.5\ \%$

7-17



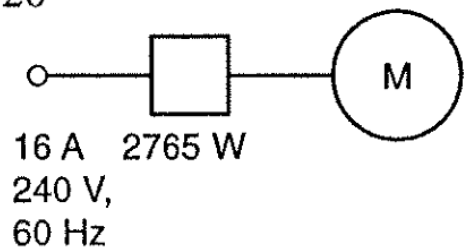
a. $P = 10^2 \times 12 = 1200$ W

b. $Q = 10^2 \times 5 = 500$ var

c. $S = \sqrt{1200^2 + 500^2} = 1300$ VA

d. $\cos\theta = 1200/1300 = 0.923$

7-20

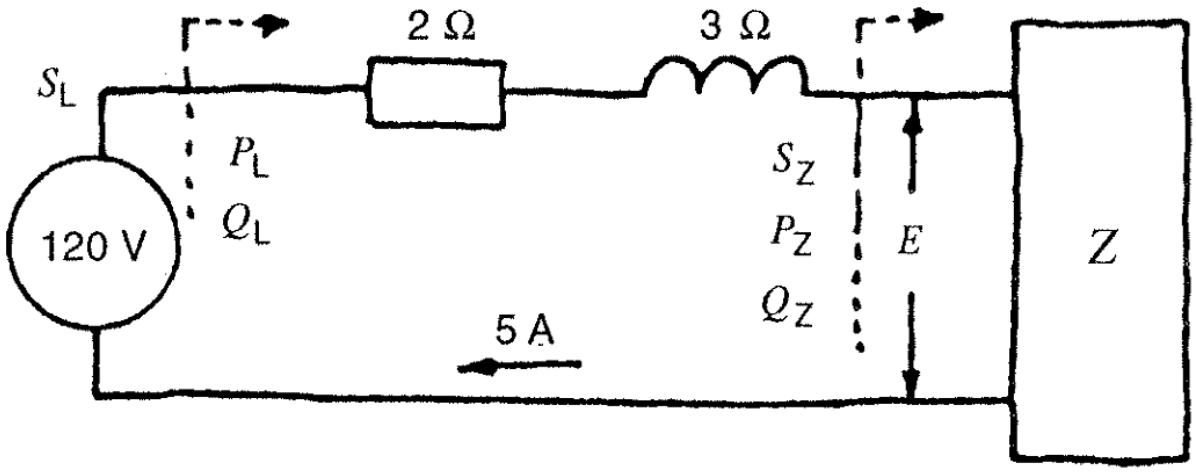


a. 2765 W

b. $Q_L = 2665 - 500 = 2165$ var

$S = \sqrt{2165^2 + 2765^2} = 3512$ VA

c. $\cos\theta = \dfrac{2765}{3512} = 0.787$



$S_L = 120 \times 5 = 60$ VA $\qquad P_L = 0.6 \times 600 = 360$ W

$Q_L = \sqrt{600^2 - 360^2} = +480$ var

(positive because the power factor is lagging).

$P_{resistor} = 5^2 \times 2 = 50$ W $\qquad \therefore P_Z = 360 - 50 = 310$ W

$Q_{induct} = 5^2 \times 3 = 75$ var

$Q_Z = 480 - 75 = 405$ var

The 120 V source supplies 480 var, and 75 var is absorbed by the inductor; the remainder must be absorbed by Z.

$S_Z = \sqrt{310^2 + 405^2} = 510$ VA

a. $E = S_Z/I = 510/5 = \underline{102\text{ V}}$

b. $Z = E/I = 102/5 = \underline{20.4\ \Omega}$

also, $\cos\theta = 310/510 = 0.607 = \cos 52.56°$

$\therefore\ Z = 20.4\ \angle{-52.56°} = 20.4 \cos(-52.56) + j \sin(-52.56)$

$= 12.4 - j\,16.2$