Tutorial 6 Solutions

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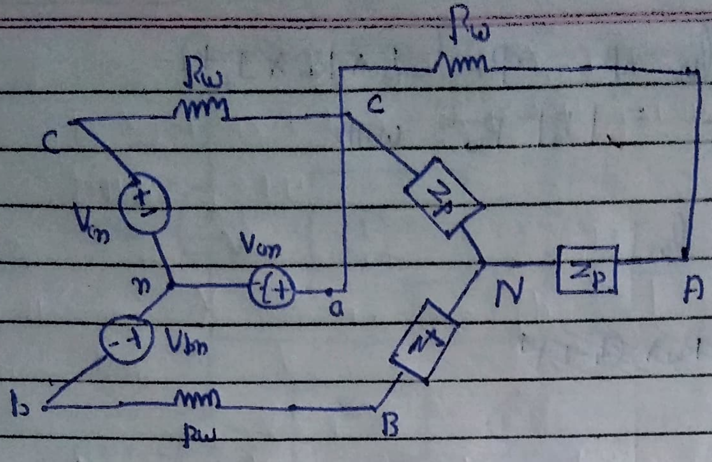
Ans 1)



Given:

Z_p is parallel combination of :-
$C = 1mF$
$L = 100mH$
$R = 10\Omega$

- Source has positive phase sequence
- operating frequency :- 50 Hz

$V_{ab} = 208\angle 0° V$

$R_w = 0$

To find :

a) all phase and voltages
b) all line voltages
c) all line currents
d) total power drawn by load

⇒ Relation of phase voltage :- $V_{ab} = \sqrt{3}\, V_p \angle 30°$

$$\Rightarrow V_p = \frac{V_{ab}}{\sqrt{3}\angle 30°} = \frac{208\angle 0°}{\sqrt{3}\angle 30°} = 120.08\angle -30° V$$

→ Now, the phase voltage $V_{an} = V_p$

⇒ $V_{an} \Rightarrow 120.08\angle -30° V$ Ans

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Now, the voltages are shifted by 120° since the source have positive phase sequence. Thus

$V_{bn} = 120.08 \angle -150°$ V Ans.
$V_{cn} = 120.08 \angle -270$ V Ans.

(b) The line voltage V_{ab} is :-
$V_{ab} = 208 \angle 0°$ V Ans.

The voltages are shifted by 120° since the sources have positive phase sequence. Thus,
$V_{bc} = 208 \angle -120°$ V Ans.
$V_{ca} = 208 \angle -240°$ V Ans.

(c) Now, total current needs to be calculated, for that total impedance needs to be calculated first.

$X_L = j 2\pi f L$
$= j 2\pi\, 50 \,(100 \times 10^{-3})$
$= j\, 31.41 \,\Omega$

$X_C = 1/j 2\pi f c$
$= 1/j 2\pi\, 50 \,(10^{-3})$
$= -j 3.1833 \,\Omega$

Now, it is given that R, L, C are in parallel. Hence, the total impedance will be :-

$$Z_P = \frac{R X_L X_C}{R X_L + R X_C + X_L X_C}$$

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$$\Rightarrow \frac{10 \times j31.415 \times (-j3.113)}{10 \times j31.415 + 10 \times (-j3.183) + (j31.415)(-j3.183)}$$

$= 1.115 - j3.147\,\Omega$

↳ For the Y connection: the phase and line current are equal;

$$I_{aA} = \frac{V_{an}}{Z_p} = \frac{120.08\angle -30^\circ}{1.115 - j3.147}$$

$= 35.97\angle 40.5^\circ$ A

Thus,

$I_{aA} = 35.97\angle 40.5^\circ$ A Ans

↳ Now, the currents are shifted by 120° since the source has positive phase sequence. Thus,

$I_{bB} = 35.97\angle -79.5^\circ$ A Ans

$I_{cC} = 35.97\angle -199.5^\circ$ A Ans

(d) The equation of power drawn by single phase;

$P_{AN} = V_{AN}\, I_{aA} \cos(\phi_v - \phi_I)$

$= (120.08)(35.97)\cos(-30^\circ - 40.5^\circ)$

$= 1442.5$ W.

total power = 3 × single phase power = 3 × 1442.5

$= 4327.5$ W Ans

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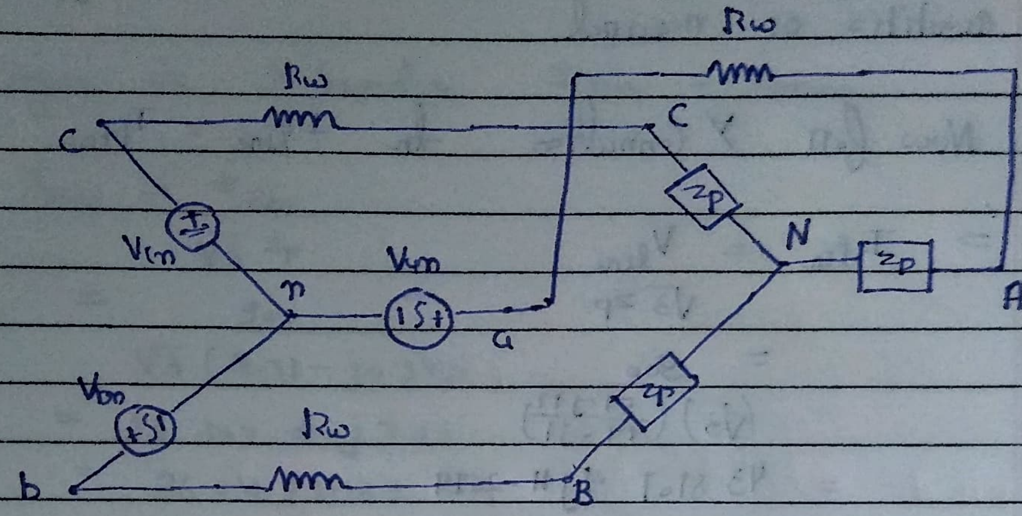
Ans 2)



Given: Positive phase sequence
line voltage :- 300V
Z_P is parallel combination of
$C = 5 - j3\,\Omega$
$L = 9 + j2\,\Omega$
$R_w = 0$

to find :- (a) power factor of source
(b) total power supplied by source
(c) find (a) and (b) if $R_w = 1\Omega$

⇒ first will calculate the value of Z_P :

$$Z_P = \frac{(5-j3)(9+2j)}{(5-j3)+(9+2j)}$$

$$= \frac{45 + j10 - j27 + 6}{14 - j1}$$

$$= \frac{51 - j17}{14 - j1}\,\Omega$$

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→ Now for the factor, the current and voltage both quantities are measured

- Now for Y connection, the $I_{line} = I_{phase}$

$$\Rightarrow I_{line} = \frac{V_{line}}{\sqrt{3}\, Z_p}$$

$$= \frac{300}{(\sqrt{3})\left(\frac{51-j17}{14-j1}\right)}$$

$$= 43.8107 + j11.2074$$

$$= 45.22 \angle 14.35^\circ \text{ A}$$

Now, power factor $= \cos(\theta - \phi)$

$$= \cos(0 - 14.35^\circ)$$

$$= \cos(-14.35^\circ)$$

$$= \boxed{0.968755} \text{ Ans}$$

(b) Total power supplied by source -

$$\text{Power} = \sqrt{3}\, V_L I_L \cos(\theta - \phi)$$

$$= \sqrt{3} \times 300 \times 45.22 \cos(-14.35^\circ)$$

$$= 22764 \text{ W} \quad \text{Ans}$$

(c) Now, we have the $R_w = 1\Omega$.

- So we need to again calculate the Z_p.

$$Z_p = 1 + \frac{(5-j3)(9+j2)}{(5-j3)+(9+j2)}$$

$$= \frac{1 + 45 + j10 - j27 + 6}{14 - j1}$$

$$= \frac{1 + 51 - j17}{14 - j1}$$

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$= 4.71 - j0.949$

c. Now again in Y connection $I_{line} = I_{phase}$

$\Rightarrow I_{line} = \dfrac{V_{line}}{\sqrt{3}\, Z_p}$

$= \dfrac{300}{\sqrt{3}\,(4.71 - j0.949)}$

$= 35.334 + j7.12$

$= 36.04 \angle 11.39° \text{ A}$

$\Rightarrow$ Power factor $= \cos(\theta - \phi)$

$= \cos(0 - 11.39°)$

$= \cos(-11.39°)$

$= \boxed{0.980306}$ Ans

$\rightarrow$ Now, total power supplied by source is

Power $= \sqrt{3}\, V_L I_L \cos(\theta - \phi)$

$= \sqrt{3} \times 300 \times 36.04 \cos(0 - 11.39°)$

$= 18358 \text{ W}$ Ans