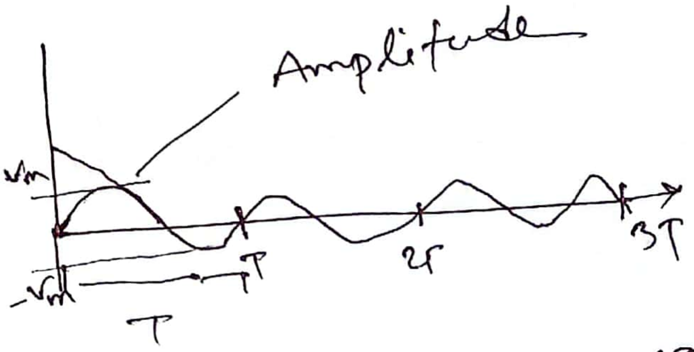
Date: 23-03-20..

Ac circuit Analysis

Sinosoid :



$V_m - (-V_m) = 2V_m$

$\Rightarrow T = \frac{1}{f}$ একক = second.

And $\omega = 2\pi f$

$f = 50\ Hz$

$\therefore T = \frac{1}{f} = \frac{1}{50} = 0.02\ s$

A Sinosoid is a signal that has from of the sine and cosine function.

* $V(t) = V_m \sin(\omega t + \phi)$

Amplitude — Angular — phase
signal

$= 10 \sin(5t + 60^\circ)$

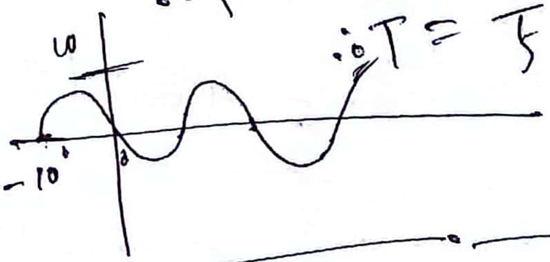
Example - 9.1 & 9.2

$V_m = 10\,V$
$\phi = 60^\circ$

$\omega = 2\pi f$
$\Rightarrow 5 = 2\pi f$
$\therefore f = \frac{5}{2\pi} = 0.79\ Hz$
$\therefore T = \frac{1}{f} = 1.256\ s$

for -20°:
$= \sin(\omega t + 20)$

for $+20^\circ$:
$= \sin(\omega t - 20)$



N.B

* $\sin(\omega t \pm 180^\circ) = -\sin \omega t$
* $\cos(\omega t - 180^\circ) = -\cos \omega t$
* $\sin(\omega t \pm 90^\circ) = \pm \cos \omega t$
* $\cos(\omega t \pm 90^\circ) = \mp \sin \omega t$

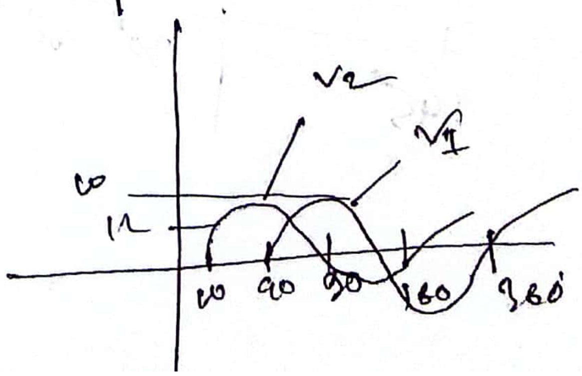
$V_1 = -10 \cos(\omega t + 50^\circ)$

$V_2 = 12 \sin(\omega t - 60^\circ)$

Apply the rule:

$V_1 = -10 \cos(\omega t + 50^\circ)$
$= 10 \sin(\omega t + 50^\circ - 90^\circ)$
$= 10 \sin(\omega t - 40^\circ)$

V_2 lead by V_1 by 30°



Q.2 Given that,

$$i_1 = -4\sin(377t + 55^\circ)$$

$$i_2 = 5\cos(377t - 65^\circ)$$

Here, $i_1 = -4\sin(377t + 55^\circ)$

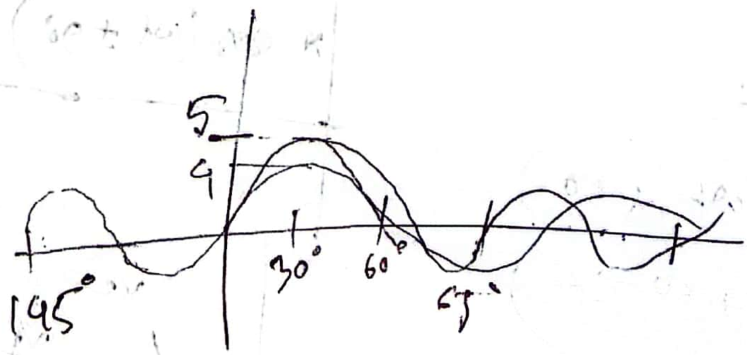
$$= 4\cos(377t + 55^\circ + 90^\circ)$$

$$= 4\cos(377t + 145^\circ)$$

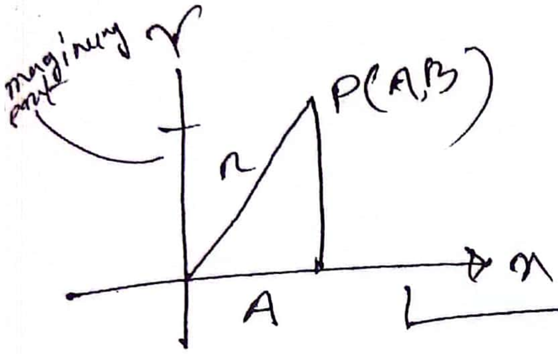
$$i_2 = 5\cos(377t - 65)$$

$\therefore i_2$ leads for $(145 - (-65))$

$= 210^\circ$ Ans.



Date: 25-03-24



real part,

$P = A + iB \rightarrow$ Rectangular form

$r = \sqrt{A^2 + B^2}$

$\phi = \tan^{-1}\frac{B}{A}$

$P = \underset{\text{amplitude}}{r} \angle \underset{\text{phase}}{\phi} \rightarrow$ Polar form

Phasor: A phasor is a complex number that represent the amplitude and phase of a sinusoide.

$v(t) = V_m \cos(\omega t + \phi)$

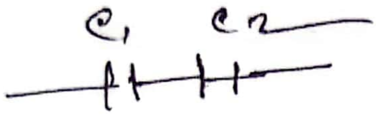
$v(t) = V_m \angle \phi$

Q: How to write polar form?

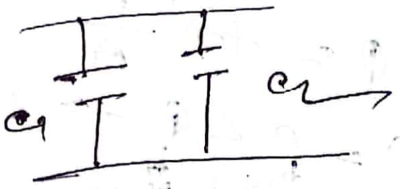
Date: 30-03-24

Equivalent capacitance:

inductance → same as resistance



$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$



$$C_{eq} = C_1 + C_2$$

impedance: প্রকাশ করা হয় Z

$$Z = R + jX$$

$X \rightarrow (X_C + X_L)$

R → Resistance Ω

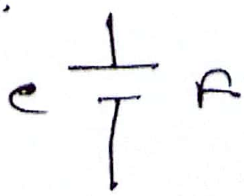
X → Reactance Ω

∴ ~~impede~~ impedance একক Ω.

capacity Reactance:

$$X_C = \frac{1}{j2\pi f C} \quad \Omega$$

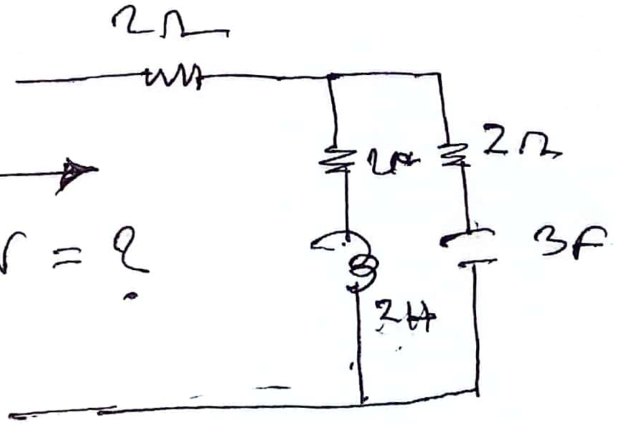
$$= \frac{1}{\omega C}$$



Inductive Reactance:

$X_L = j2\pi f L$

$= j\omega L$



$Z_{eq} = ?$

frequency = 50Hz

$C = 3$

$X_C = \frac{-j}{2\pi f C} = -j \times 2\pi \times 50 \times 3$

$= -j1.06 \times 10^{-3}$

$\frac{2 \times 2}{2+2} = 2+2 = 3$

$L = 2H$

$X_L = j2\pi f L = j \times 2\pi \times 3$

$= j628.32$

$X = X_C + X_L$

$= -j1.6 \times 10^{-3} + j628.32$

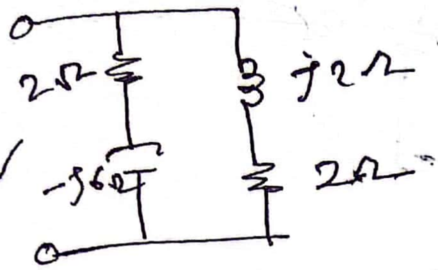
Impedance:

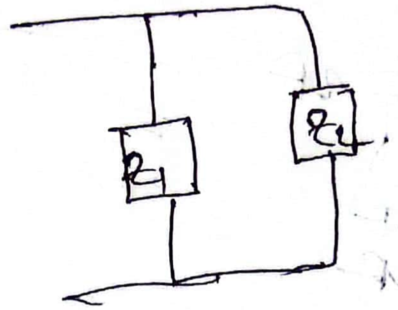
$Z = R + X$

$= 3 + j628.319$

$= 631.319\,\Omega$

Date:





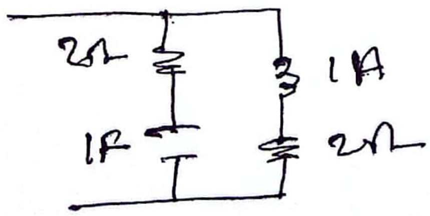
$Z_1 = (2 - j6)\ \Omega$

$Z_2 = (2 + j2)\ \Omega$

$$\therefore Z_{eq} = \frac{Z_1 \times Z_2}{Z_1 + Z_2}$$

$$= \frac{(2-j6)(2+j2)}{(2-j6)(2+j2)}$$

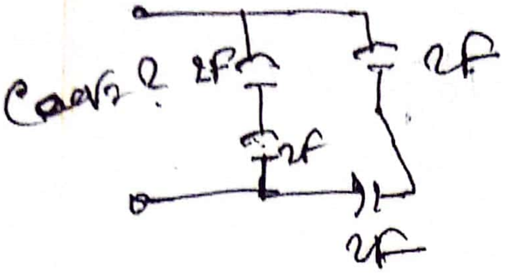
$= 3 + i$



$X_1 = \frac{1}{j2\pi f \times C} = -j \ldots$

$X_2 = j2\pi f c = j \ldots$

(A)



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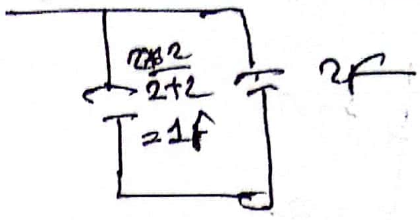
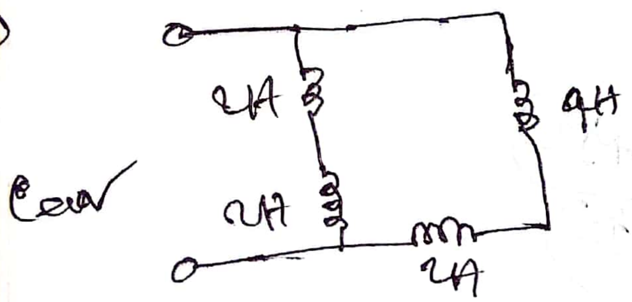
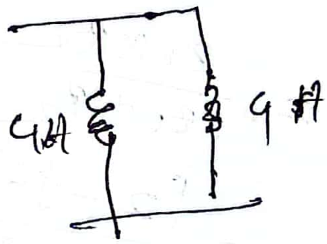


$\therefore C_{eq} = 1 + 1 = 2F$

(A)





$L_{eq} = \frac{4\times 4}{4+4} = 2H.$

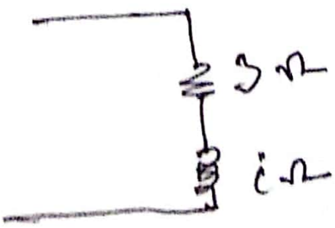
(A) $Z = 3 + i$

Resistance

x

$X_C = \frac{1}{j}$

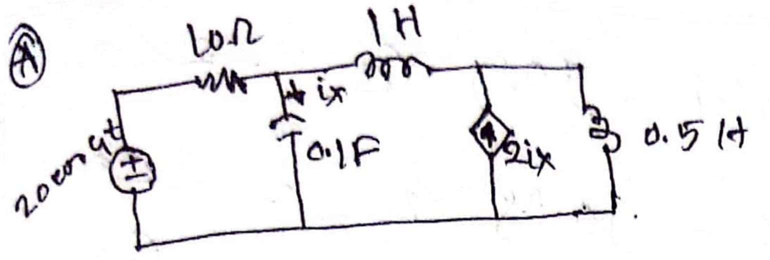
$X_L = j$



$\rightarrow$ $X_L = j\,2\pi f_2$

$L = \frac{j}{j\,2\pi f}$

Ⓐ



$i_x = ?$

$20\cos 4t$

$V_m \cos(\omega t + \phi)$

$V_m \angle \phi$

$20\angle 0$

Here

$\omega = 4$

for 0.1F, $\quad X_c = \frac{1}{j\omega c}$

$= \frac{1}{j \times 4 \times 0.1}$

$= -j2.5\ \Omega$

$i_x = \frac{V_1}{-j2.5}$

for, 1H $\quad X_L = j \times 4 \times \cancel{0.5}\ 1$

$= j4\ \Omega$

for, $i_3 = 2i_x$

$= 2 \times \frac{V_1 - 0}{-j2.5} =$

0.5 H, $\quad X_L = j \times 4 \times 0.5$

$= j2\ \Omega$

Apply nodal analysis,

$I_1 = I_x + I_2$

$\Rightarrow \frac{20\angle 0 - V_1}{10} = \frac{V_1}{-j2.5} + \frac{V_1 - V_2}{j4}$

$\Rightarrow 2\angle 0.1 V_1 = j0.4 V_1 - j0.25 V_1 + j0.25 V_2$

(Div. by 10)

$\Rightarrow -0.1 V_1 - j0.15 V_1 - j0.25 V_2 = 2\angle 0$

$\Rightarrow (0.1 - j0.15) V_1 - j0.25 V_2 = 2\angle 0$ ——— (i)

Apply nodal analysis in node (2)

$I_2 + I_3 = I_4$

$\Rightarrow \frac{V_1 - V_2}{j4} + \cancel{}\, 2i_x = \frac{V_2}{j2}$

$\Rightarrow \frac{V_1 - V_2}{j4} + \frac{2V_1}{-j2.5} = \frac{V_2}{j2}$

$\Rightarrow 11 V_1 + 15 V_2 = 0$ ——— (ii)

For V_1 and V_2

$$\Delta = \begin{bmatrix} -0.1 - j0.15 & -j0.25 \\ 4 & 15 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 2\angle 0 \\ 0 \end{bmatrix}$$

CS CamScanner

$$\Delta_1 = \begin{bmatrix} 220 & -j0.25 \\ 0 & 15 \end{bmatrix} =$$

$$\therefore V_1 = \frac{\Delta_1}{\Delta}$$

$$V_2 = \frac{\Delta_2}{}$$

Date: 20-04-2024

Chapter-II :

* Ac power analysis :

i) Instantaneous power :

$V(t) = V_m \cos(\omega t + \theta_v) = V_m \angle \theta_v$

$I(t) = I_m \cos(\omega t + \theta_i) = I_m \angle \theta_i$

$$P = VI$$

$$= 2 \cdot \frac{1}{2} V_m \cos(\omega t + \theta_v) I_m \cos(\omega t + \theta_i)$$

$$= \frac{V_m I_m}{2} \left[\cos(\omega t + \theta_v + \omega t + \theta_i) + \cos(\omega t + \theta_v - \omega t - \theta_i) \right]$$

$$= \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i) + \frac{1}{2} V_m I_m \cos(2\omega t + \theta_v + \theta_i)$$

Avg power :

$$P = \frac{1}{T} \int_0^T p(t)\, dt$$

$$\boxed{P = \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i)}$$

p.f power factor

V_m = voltage angle

I_m = current angle.

Problem: 11.1 P(459)

$v(t) = 10\angle 20^\circ$

$i(t) = 2\angle 60^\circ$

Here,

$V_m = 10$

$I_m = 2$

$\theta_v = 20^\circ$

$\theta_i = 60^\circ$

$\therefore P = \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i)$

$= \frac{1}{2} 10 \times 2 \cos(20^\circ - 60^\circ)$

$= \frac{1}{2} 20 \cos(60^\circ)$

$= 9.85$ Ans.

N.B: যদি $\cos \theta = 90^\circ$ আবার্তিত হয় তাহলে মান শূন্য।

Power factor:

4.2:

$Z = 30 - j70\ \Omega$

$V = 120\angle 0^\circ$

Find $P_{avg} = ?$

V = Voltage
Z = Impedance

Sol^n:

$V = IZ$

$$I = \frac{V}{Z} = \frac{120\angle 0^\circ}{30 - j70}$$

$$= 1.57\angle 66^\circ$$

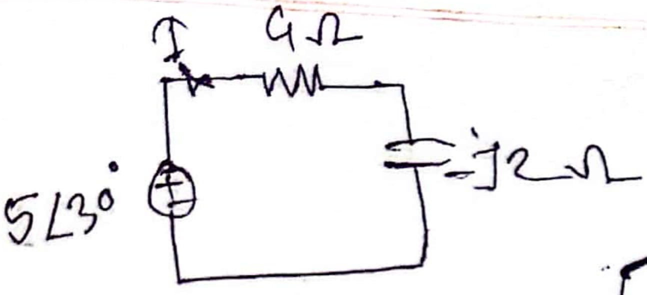
$\therefore I = 1.57\angle 66^\circ$

$$\therefore P_{avg} = \frac{1}{2} * 120 * 1.57 \cos(0 - 66)$$

$$= 15.7 \cos(-66)$$

$$= 6.38$$ Ans

4.B



Sol^n:

For source:

$V = 5\angle 30^\circ$

$Z = 4 - j2\ \Omega$

$I = \frac{V}{Z}$

$= \frac{5\angle 30^\circ}{4 - j2}$

$= 1.118\angle 56^\circ$

$P_{avg} = \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i)$

$= \frac{1}{2} * 5 * 1.118 \cos(30^\circ - 56^\circ)$

$= \cancel{14.71}$

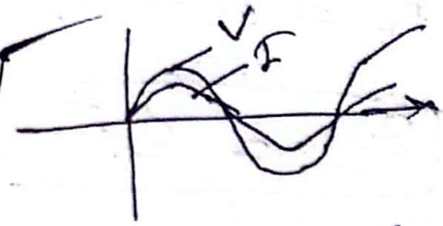
$= 2.50\ W$

For 4Ω load:

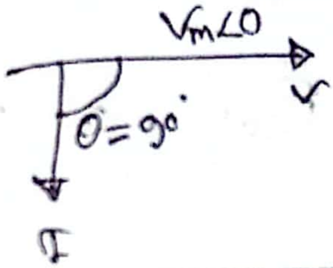
$I = 1.118\angle 56.56$

$V_R = IR$

$= 4 \times 1.118\angle 56.56$



inductive load
(current lag)



Capacitive load.
[current lead]

NB: inductive & capacitive load
এর 90° হয় $P_{Avg} = 0$।

$P_{avg} = \frac{1}{2} * 4.47 * 1.118 * \cos(0^\circ)$

$= 2.50\ W$

For -j2 load:

$Z = -j2$

$I = 1.118\angle 56.56^\circ$

$V_L = (-j2) * 1.118\angle 56.56^\circ$

$= 2.22\angle -33.4$

$P_{avg} = \frac{1}{2} * 2.22 * 1.118 \cos(-33.4 - 56.56)$

$= 0.0066$

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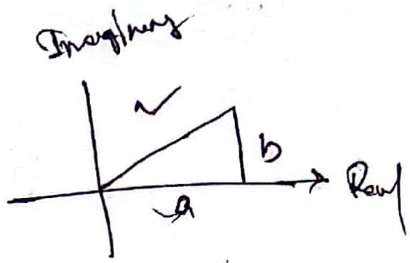
Date: 22-04-2

$Z_{th} = R_{th} + jX_{th}$



$r = \sqrt{a^2 + b^2}$

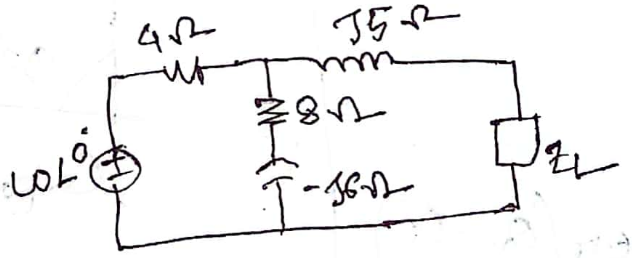
$Z_L = R_L + jX_L$

$\boxed{Z_L = Z_{th}^*} = R_{th} - jX_{th}$

$R_L = |Z_{th}| = \sqrt{R_{th}^2 + X_{th}^2}$

$$P_{max} = \frac{|V_{th}|^2}{8 R_{th}}$$

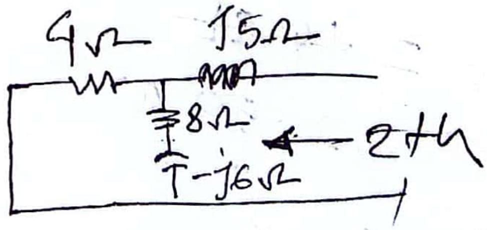
Example - 11-5 :



Find Z_L = ?

P_{max}

Soln: For Z_{th}

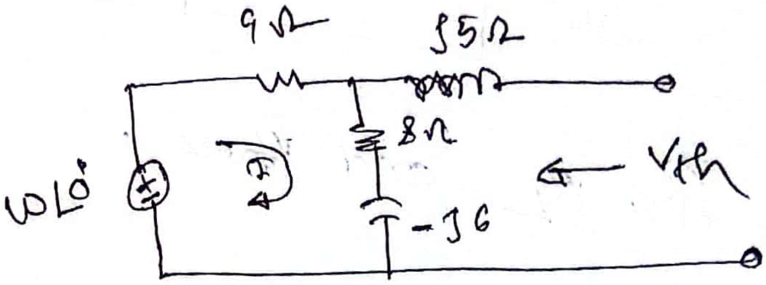


$$Z_{th} = \frac{(8-j6)\times 4}{8-j6+4} + j5$$

$$= \underset{R_{in}}{2.93} + j\underset{X_{th}}{4.47}\ \Omega$$

$\therefore Z_L = Z_{th}^{*} = (2.93 - j4.97)\ \Omega$

For V_{th}:



$10\angle 0^\circ + 9I + 8i - j6 = 0$

$V_{th} = IZ$

$\Rightarrow 10\angle 0^\circ + 12I - j6 = 0$

$I = \dfrac{10\angle 0}{12 - j6}$

Here, $Z = 8 - j6$

$V_{th} = \dfrac{10\angle 0}{12 - j6} \times (8 - j6)$

$= (7.33 - j1.33)$

$\boxed{11.5}$

$|V_{th}| = \sqrt{(7.33)^2 + (-j1.33)^2}$

$= 7.45\ V$

$\therefore P_{max} = \dfrac{(7.45)^2}{8 \times 2.93}$

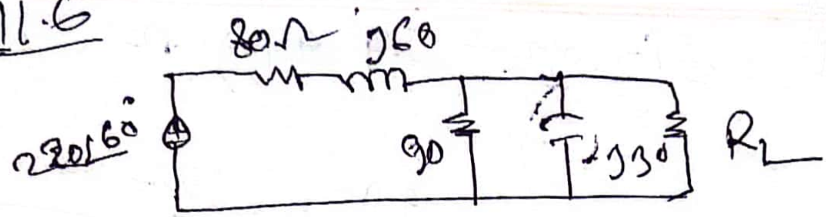
$V_{th} = 7.45$
$R_{th} = 2.93$

$= 2.368\ W$

Ans

V.V.I

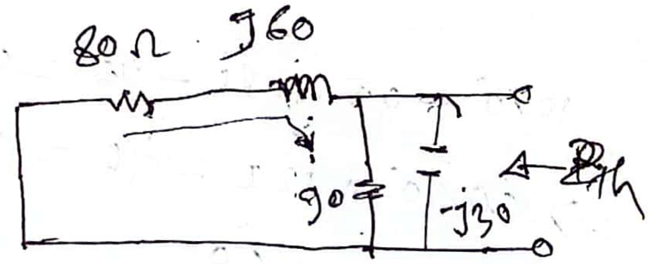
P.P: 11.6



Find R_L and P_{max}.

Soln:

For Z_{th}:



$$\cancel{\frac{(80+j60)\times 90}{90+j60}+80}$$

$$\cancel{\Rightarrow 107.69 + j41.53}$$

$$\cancel{R_{th} \quad X_{th}}$$

$$\cancel{\frac{(80+j60)\times 90}{(80+j60)+90}} =$$

$$Z_{th} = 90 \| (-j30) \| (80+j60)$$

$$= \frac{90 \times -j30}{90+(-j30)}$$

$$= (9-j27)\Omega \| (80+j60)$$

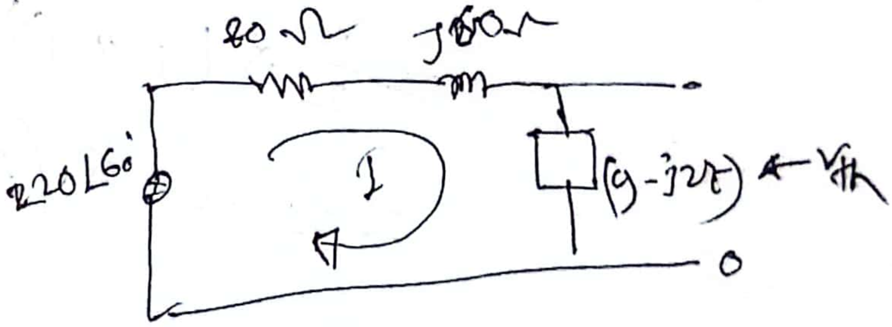
$$= \frac{(9-j27) * (80+j60)}{(9-j27)+(80+j60)}$$

$$= 17.90 - j2.99$$

Now $R_L = |Z_{th}| = \sqrt{(17.90)^2 + (-2.99)^2}$

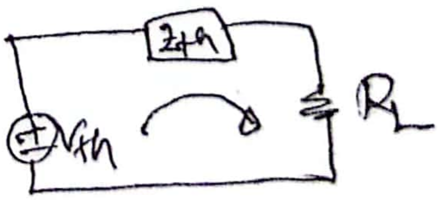
$$= 30\,\Omega$$

For V_{th}:



$$-220\angle 60^\circ + (80 + j60)I + (9 - j27)i = 0$$

$$I = \frac{220\angle 60^\circ}{80 + j60 + 9 - j27}$$



$$= 1.78 + j1.47$$

$$V_{th} = (1.78 + j1.47)(9 - j27) = 55.71 - j34.83$$

$$= 65.7\angle -32.01^\circ$$

$$I = \frac{V_{th}}{Z_{th} + R_L}$$

$$\frac{6 \times 7}{6+7} + 5$$

$$= \frac{65.7\angle -32.01^\circ}{(17.90 - j2.99) + 30}$$

$$= 8.23\,\Omega$$

$$= 1.29 - j0.09$$

$$-16 + 4i + 6i = 0$$

$$|I| = 1.29$$

$$= 10I = 16$$

$$P_{max} = \frac{1}{2}|I|^2 \times R_L$$

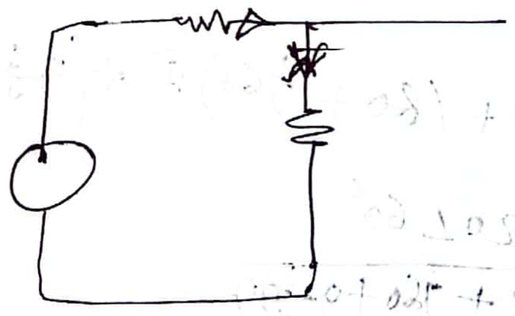
$$\therefore I = \frac{16}{10}$$

$$= \frac{1}{2} \times (1.29)^2 \times 30$$

$$= 1.6$$

$$= 23.06\ W\ (Am)$$

$$V =$$



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