(15) Series & Parallel AC Circuits

DC Circuit এর ক্ষেত্রে Inductor → Short Circuit

Capacitor → open Circuit

Resistor → Heat হিসেবে দেয় (active power)

Capacitor, Inductor → Power Store করে (Reactive Power)

$$\boxed{Z_R = R\angle 0^\circ}$$
$= R\cos 0 + jR\sin 0$
$= R$

Z_R = impedance

Complex Number: $a + ib$ → Cartesian or Rectangular format

a → Real, ib → imaginary

i এর বদলে j ইউজ করা হয়

$a + jb \rightarrow M\angle\theta$ [Polar Form]

Calculator এ কনভার্ট

→ এভাবে হবে Format এ হবে

$M = \sqrt{a^2+b^2}$ magnetude

$\theta = \tan^{-1}\frac{b}{a}$

$(a+jb) + (c+jd)$
$= (a+c) + j(b+d)$

$$\left[\begin{aligned} j \times j &= j^2 = -1 \\ j^3 &= j^2 \times j = -j \\ j^4 &= j^2 \times j^2 = 1 \end{aligned}\right]$$

$M_1\angle\theta_1 \times M_2\angle\theta_2$
$= M_1 \times M_2 \angle(\theta_1 + \theta_2)$

$$\frac{M_1\angle\theta_1}{M_2\angle\theta_2} = \frac{M_1}{M_2}\angle(\theta_1 - \theta_2)$$

$M\angle\theta \rightarrow a + jb$
$= M\cos\theta + jM\sin\theta$

$$Z_L = X_L \angle 90^\circ \qquad \because X_L = \omega L$$

$$= \omega L \angle 90^\circ$$

$$= jX_L \quad [\because X_L \cos 90^\circ + jX_L \sin 90^\circ]$$

$$= j\omega L$$

$$Z_C = X_L \angle -90^\circ$$ Voltage Lags current

$$= X_C \cos(-90^\circ) + jX_C \sin(-90^\circ)$$

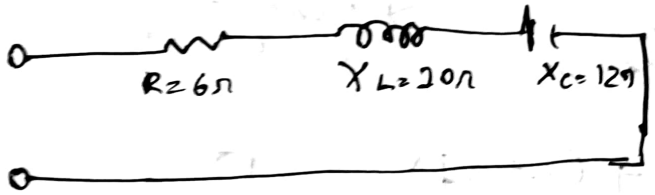
$$= -jX_C$$

Series Configuration:

$$Z_T = Z_1 + Z_2 + Z_3 + \dots + Z_n$$

Ex - 15.23

Find Z_T



Ans:

$$Z_T = Z_1 + Z_2 + Z_3$$

$$= R\angle 0^\circ + X_L \angle 90^\circ + \angle X_C \angle -90^\circ$$

$$= R + jX_L - jX_C$$

$$= R + j(X_L - X_C) = 6\Omega + j(10\Omega - 12\Omega)$$

$$= 6\Omega - j2\Omega$$

$$Z_T = 6.325\Omega \angle -18.43$$ (by using Calc.)

$$I = \frac{E/V}{Z_T}$$

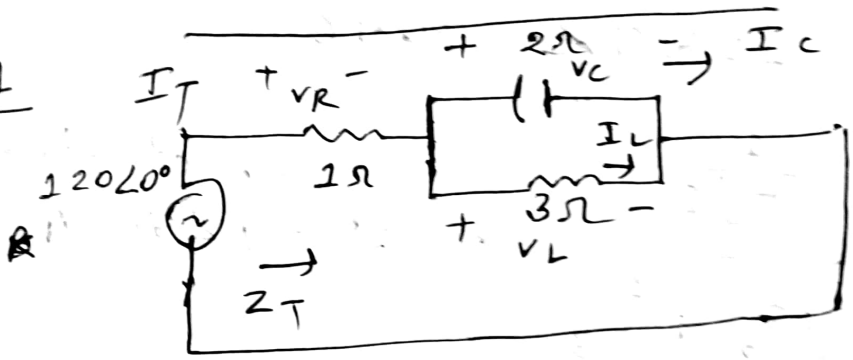
I = current
E = supply voltage
Z_T = Total impedance

$$P = EI\cos\theta_T$$

P = Power
E = voltage
I = current
θ_T = phase angle between I & E ($E - I$)

(16) Series-Parallel ac Networks

Ex 16.1



a) Z_T b) I_T c) V_R & V_C
d) I_C e) Power delivered f) power factor

Ans:

a) $Z_T = 1 + (-j2 \parallel j3)$

(series → parallel)

$$= 1 + \left(\frac{1}{-j2} + \frac{1}{j3}\right)^{-1}$$

[capacitor $-j$; inductance j]

$$= 6.08\angle -80.54^\circ\ \Omega$$

b) $$I_T = \frac{V}{Z_T} = \frac{120\angle 0^\circ}{6.08\angle -80.54^\circ} = 19.74\angle 80.54\ A$$

c) $V_R = I_T \times R = 19.74\angle 80.54° \times 1 = 19.74\angle 80.54°$

(Resistor এর across voltage)

$V_L = V_C$ [Parallel এর voltage same]

$V_{supply} = V_R + V_C$

$\Rightarrow 220\angle 0° = 19.74\angle 80.54 + V_C$

$\Rightarrow V_C = 118.4\angle -9.46$

d) $I_C = \dfrac{\frac{1}{-j2}}{\frac{1}{-j2} + \frac{1}{j3}} \times 19.74\angle 80.54°$ (current divider rule)

$= 59.22\angle 80.54°$

I_C দিয়ে V_C বের করা:

$V_C = I_C \times -j2$

e) Real Power.

$P = I^2 R$

$= I_T^2 R$

$= (19.74)^2 \times 1$

$= (19.74)^2$

$= 389.67\ W$

f) $PF = F_p = \cos\theta$ ← Z_T এর angle

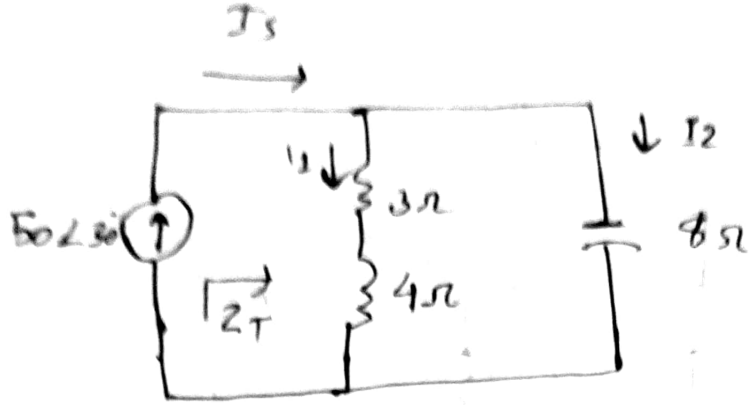
$= \cos 80.54°$

$= 0.164$ (leading)

If $\theta \to -$ Leading Power factor

$\theta \to +$, lagging

Ex - 16.2



Find I_1, I_2, I_s, Z_T

Ans: $I_1 = \dfrac{\frac{1}{3+j4}}{\frac{1}{3+j4} + \frac{1}{-j8}} \times 50\angle 30°$ (total) current divider rule

$= 80\angle -6.87°$

$I_2 = \dfrac{\frac{1}{-8j}}{\frac{1}{3+j4} + \frac{1}{-j8}} \times 50\angle 30°$

$= 50\angle 136.26°$

$I_s = I_1 + I_2$

$Z_T = \left(\dfrac{1}{3+j4} + \dfrac{1}{-j8}\right)^{-1}$

$= 8\angle 16.26°\ \Omega$

P.F. = $\cos\theta$ (Z_T এর angle)

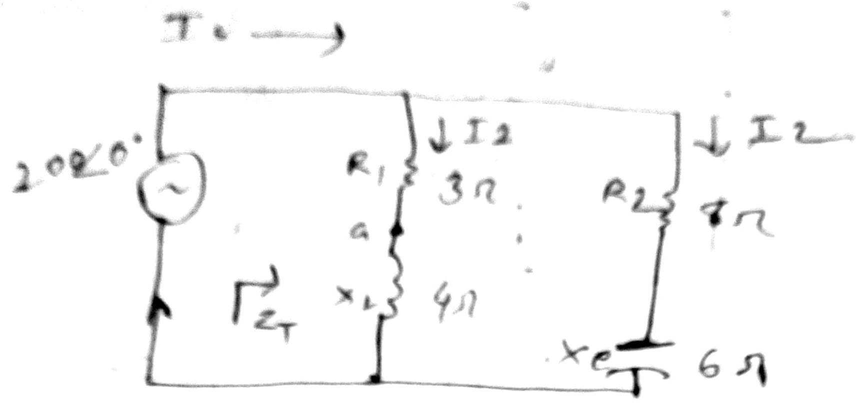
$= \cos 16.26$

$= 0.96$ (lagging) — কেন leading

$P = |I_1|^2 R$

$= 80^2 \times 3 = 19200$ W

Ex – 26.4



i) Find $Z_T = (3+j4) \parallel (8-j6)$

$$= \left(\frac{1}{3+j4} + \frac{1}{8-j8}\right)^{-1}$$

~~= 0.098 ∠ 37.99°~~

$$= 4.47 \angle 26.56°$$

ii) Find $I_S = \frac{V}{Z_T}$ ($\frac{V}{R}$ এর মত)
(Total current)

$$= \frac{100\angle 0°}{4.47\angle 26.56°} = 22.3 \angle -26.56° \text{ A}$$

iii) $$I_1 = \frac{\frac{1}{3+j4}}{\frac{1}{3+j4} + \frac{1}{8-j6}} \times 22.3 \angle -26.56°)$$ $\rightarrow I_S$

$$= 19.94 \angle -53.12° \text{ A}$$

iv) $I_2 = \dfrac{\dfrac{1}{8-j6}}{\dfrac{1}{8-j6} + \dfrac{1}{3+j4}} \times 22.36 \angle -26.56°$

$= 9.97 \angle 36.87° A$

[I_1, I_2 calculation দেখাতে হবে]

V_A একটি point এর voltage, একটি Ground এ V_L ধরা।

v) Find V_L / V_A

$V_a = (I_1) \times (j X_L)$

$= 19.94 \angle -53.12° \times j4$

~~$= 79.76$ V~~

$= 79.76 \angle 36.88°$ V

vi) $V_b = I_2 \times -jX_C$

$= 9.97 \angle 36.87 \times -j6$

~~$= 2.62$~~

$= 59.82 \angle -53.13°$ V

vii) $V_{ab} = V_a - V_b$

$= (79.76 \angle 36.88) - (59.82 \angle -53.13°)$

$= 100 \angle 73.74°$ V

viii) P.F $= \cos\theta = \cos 26.56° = 0.89$ (lagging)

ix) Power delivered $= |I_1|^2 R_1 + |I_2|^2 R_2$

$= (19.94^2 \times 3) + (9.97^2 \times 8) = 1988.02$ W