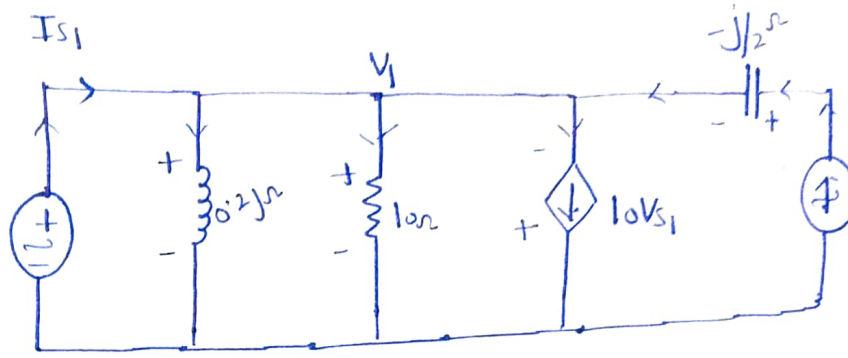
Q)



(1)

$L = 1mH = 10^{-3}\ H$

$X_L = j\omega L = j \times 200 \times 10^{-3}$

$= 0.2j\,\Omega$

$V_{S1} = 100\angle 60^\circ\ V$

$10V_{S1} = 1000\angle 60^\circ\ A$

$C = 10mF = 10 \times 10^{-3}\ F$

$X_C = \dfrac{1}{j\omega C} = \dfrac{1}{j \times 200 \times 10^{-2}} = -j/2\,\Omega$

$V_{S1}(t) = 100\cos(200t + 60^\circ)\ V \equiv 100\angle 60^\circ\ V$

$i_{S_2}(t) = 10\sin(200t)\ A \equiv 10\angle -90^\circ\ A$

(1b) $I_R = \dfrac{V_{S1}}{R} = \dfrac{100\angle 60^\circ}{10} = 10\angle 60^\circ\ A$

in time domain :-

$$\boxed{i_n(t) = 10\cos(200t + 60^\circ)\ A}$$

(1)

(1b) Complex power due to two independent sources

At node V_1 :-

$= 10\angle -90^\circ + I_{S1} = \dfrac{V_1}{0.2j} + \dfrac{V_1}{10} + 1000\angle 60^\circ$

$= 10\angle -90^\circ + I_{S1} = \dfrac{100\angle 60^\circ}{0.2\angle 90^\circ} + \dfrac{100\angle 60^\circ}{10} + 1000\angle 60^\circ$

$I_{S1} = 500\angle -30^\circ + 10\angle 60^\circ + 1000\angle 60^\circ - 10\angle -90^\circ$

$= 433.01 - j250 + 5 + j8.66 + 500 + j866.02 + j10$

$= 938.01 + j634.68$ A

$\text{magnitude} = \sqrt{(938.01)^2 + (634.68)^2}$

$= \sqrt{879862.76 + 402818.70}$

$= \sqrt{1282681.46}$

$= 1132.55$

$\text{angle} = \tan^{-1}\left(\frac{634.68}{938.01}\right)$

$= \tan^{-1}(0.6766) = 34.08$

$= 1132.55 \angle 34.08$ A (1)

⇒ Complex power due to voltage source:-

⇒ $\frac{1}{2} \times V_{s_1} \times I_{s_1}^*$

$= \frac{1}{2} \times 100\angle 60 \times 1132.55\angle -34.08$

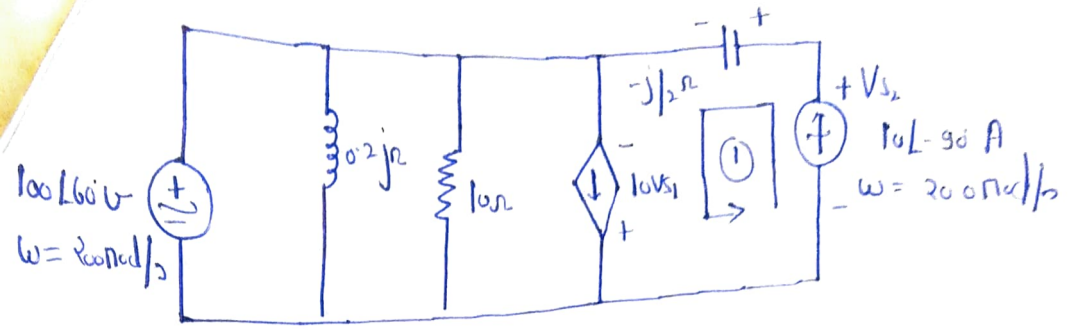
$= 56,627.5 \angle 25.92$ VA

$= 50931.07 + j24752.77$ VA (1)

Time average power = 50931.07 watts (0.5)

Reactive power = 24752.77 VAR (0.5)

Apply power due to current source -



⇒ Apply equation in loop 1 :-

$$\Rightarrow \quad 10\angle -90^\circ \times 0.5\angle -90^\circ + 100\angle 60^\circ = V_{s_2}$$

$$= \quad 5\angle -180^\circ + 100\angle 60^\circ = V_{s_2}$$

$$\Rightarrow \quad V_{s_2} = 50 + j86.6 - 5$$

$$= 45 + j86.6\ V$$

$$\text{magnitude} = \sqrt{(45)^2 + (86.6)^2}$$

$$= \sqrt{2025 + 7499.56}$$

$$= \sqrt{9524.56}$$

$$= 97.59$$

$$\text{angle} = \tan^{-1}(86.6/45)$$

$$= \tan^{-1}(1.9244)$$

$$= 62.54$$

$$V_{s_2} = 97.59\angle 62.54^\circ\ V \qquad (1)$$

Complex power due to current source :-

$$\Rightarrow \frac{1}{2} \times V_{s_2} \times I_{s_2}^*$$

$\frac{1}{2} \times 97.59 \angle 62.54 \times 10 \angle 90°$

$= 487.95 \angle 152.54$

$\Rightarrow -432.97 + j\,225.00$ VA (1)

Time average power = −432.97 watts (0.5)

Reactive Power = 225.00 VAR (0.5)

⇒ Power factor due to current source:

$\cos(\theta - \phi) = \cos(62.54 + 90)$

$= \cos(152.54)$

(1) $= -0.887$; leading

⇒ Power factor due to voltage source:

$\cos(\theta - \phi) = \cos(60 - 34.08)$

$= \cos(25.92)$

(1) $= 0.899$; ~~lagging~~ leading