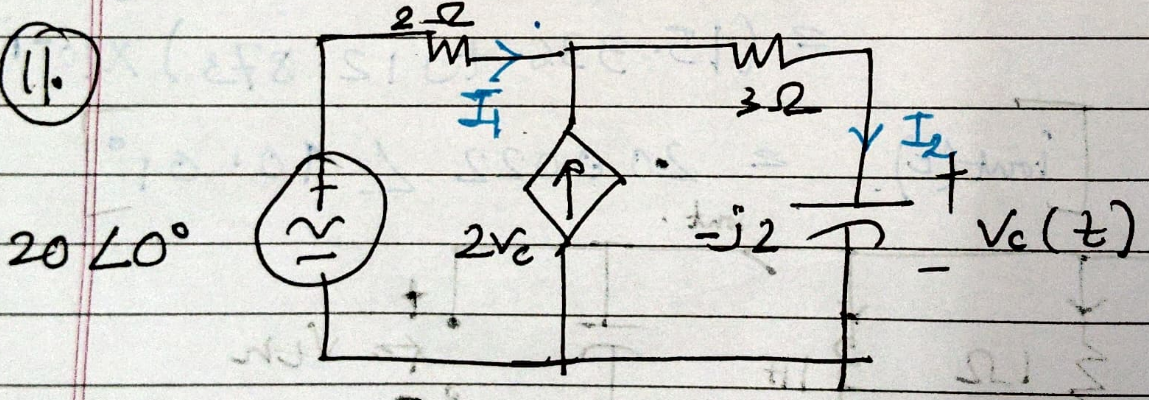
$= 20.032 \angle 38.10° \times 10$

11.



$v_c(t) = I_2 \times (-j2)$. $I_2 = \frac{V_c}{-j2}$;

Super Mesh!

$$-20\angle 0° - I_1 \times 2 + 3 \times \left(\frac{V_c}{-j2}\right) + V_c = 0 \quad \text{— (i)}$$

Nodal!

$$I_1 + 2V_c = I_2 \Rightarrow I_1 + 2V_c = \frac{V_c}{-j2} \quad \text{— (ii)}$$

① →

$-20 - I_1 \times 2 + \frac{3V_c}{2}\angle 90° + V_c = 0$

$-20 - I_1 \times 2 + j1.5V_c + V_c = 0$

$2I_1 = V_c(1 + j1.5) - 20$.

(ii) → $I_1 = j0.5V_c - 2V_c$

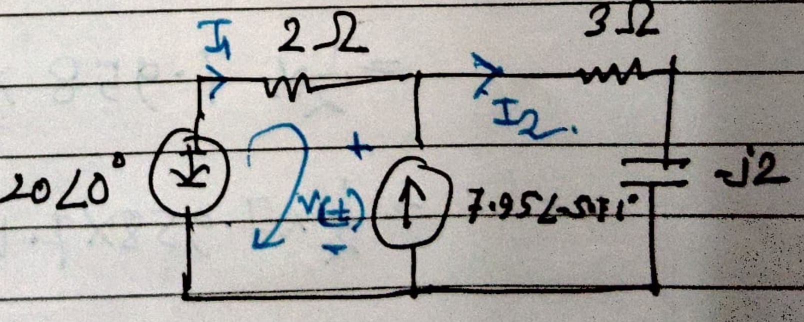
putting value ⇒ $jV_c - 4V_c = V_c + j1.5V_c - 20$

⇒ $5V_c + j0.5V_c = 20 + j \times 0$.

→ $V_c = \frac{20}{(5 + j0.5)} = (3.960 - j0.3960)$

$V_c = 3.979\angle -5.710°$

$2V_c = 7.958\angle -5.710°$



$I_2 = \frac{V_c}{-j2}$

$= \frac{7.958\angle -5.710}{2\angle -90°}$

$I_2 = 3.979\angle 84.29°$

$I_1 = I_2 + 2V_c(t) = 3.979\angle 84.29 + 7.958\angle -5.710°$

$I_1 = 8.3114 + j3.1677$

$I_1 = 8.894 \angle 20.86°$

KVL

$-20\angle 0° + 2I_1 + v(t) = 0$

$v(t) = 20\angle 0° - \cancel{17.78}\ 17.788\angle 20.86°$

$= \cancel{2.234 - j8.875 \times 10^{-1}}$

$= 3.377 - j6.334$

$v(t) = 7.178 \angle -61.93°$

$P_{avg} = \frac{1}{2} I_m V_m \cos\phi$

$= \frac{1}{2} \times 7.958 \times 7.178 \left(\cos\left(\begin{array}{c} -61.93 \\ -5.710 \end{array}\right)\right)$

$= \frac{1}{2} \times 7.958 \times 7.178 \cos(-56.22°)$

$P_{avg} = 15.88$ Watt

28 (a) $R.M.S = 3/\sqrt{2}$

(b) $\cancel{4 \sin 20t \cos 10t}$

$= 2(\sin(30t) + \sin 10t)$

$\Rightarrow \sqrt{RMS_1^2 + RMS_2^2}$

$= \sqrt{(\sqrt{2})^2 + (\sqrt{2})^2}$

$= 2.$

(c) $2 - \sin 10t$

$\cancel{= x(t) \text{ let}}$

$RMS = \sqrt{\frac{1}{T}\int_0^T [x(t)]^2 \, dt}$

$= \cancel{\int_0^T (4 - 4\sin 10t + \sin^2 10t) dt}$

$= \left[4T - 0 + \frac{T}{2}\right] = 9T/2$

$\therefore RMS = \sqrt{\frac{1}{T} \times \frac{9T}{2}} = 2.121.$

(d) $\cancel{RMS = \sqrt{\frac{1}{T}\left(\int_0^{T/2} A^2 dt + \int_{T/2}^{T}\right)}}$

$RMS = \sqrt{\frac{1}{T}\left(\int_1^3 (2.82)^2 dt + \int_3^4 0 \, dt\right)}$

$= \sqrt{\frac{1}{T} \times (2.82)^2 \times 2}$

$T = 3.$ $= 2.302$

classmate

Date
Page

35.

$$I = \frac{119\angle 3^\circ}{14\angle 32^\circ + 22\angle 0^\circ} = 0.338 - j0.557 \text{ A}$$

$$I = 0.6515 \angle -58.74^\circ$$

$$\text{Power} = \frac{1}{2} V_m I_m \cos\phi$$

$$= \frac{1}{2} \times 119 \times 0.6515 \times \cos(3^\circ - (-58.74))$$

$$= \cancel{183.53 \text{ Watt}}.\ 18.353 \text{ watt}.$$

$$S = VI^*$$

$$= V(0.338 + j0.557)$$

$$= 119\angle 3^\circ \times 0.6515 \angle 58.74^\circ$$

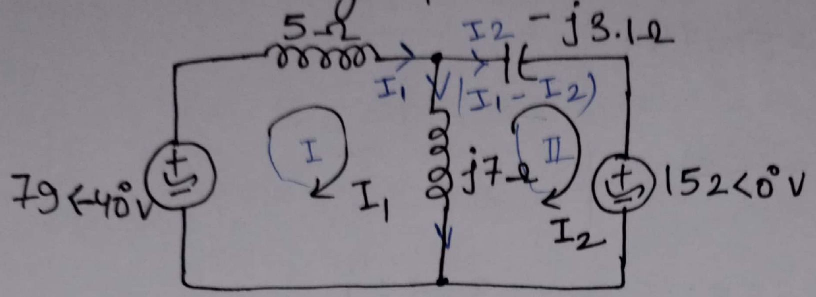
$$= 36.707 + j68.287 \text{ VA}$$

$$S = 77.527 \angle 61.74^\circ \text{ VA}.$$

$$\text{power factor} = \frac{P}{S} = \frac{18.353}{77.527}$$

$$\cos\theta = 0.236$$

Q5) With Regards to the two-mesh circuit depicted in fig. determine the average power observed by each passive element, and the average power supplied by each source, and verify that the total supplied average power = the total absorbed average power



KVL I: $-79\angle-40^\circ + 5I_1 + 7j(I_1 - I_2) = 0$

$$-(60.51 - 50.78j) + 5I_1 + 7jI_1 - 7jI_2 = 0$$

$$\Rightarrow \boxed{(5+7j)I_1 - 7jI_2 = 60.51 - 50.78j} \quad \text{— (1)}$$

KVL II: $-3.1j\, I_2 + 152 - 7j(I_1 - I_2) = 0$

$$\boxed{-7j\, I_1 + 3.9j\, I_2 = -152\angle 0} \quad \text{— (2)}$$

Solving (1) and (2) By Cramer's Rule.

$$\Delta = \begin{vmatrix} 5+7j & -7j \\ -7j & 3.9j \end{vmatrix}$$

$$= 3.9j(5+7j) - 4.9j$$

$$= -27.3 + 19.5j - 4.9j$$

$$\boxed{\Delta = -27.3 - 29.5j}$$

Scanned with OKEN Scanner

$$\Delta_1 = \begin{vmatrix} 60.51-50.78j & -7j \\ -152 & 3.9j \end{vmatrix}$$

$$\Delta_1 = 198.04 + 235.98j - 1064j = 198.04 - 828.02j$$

$$\Delta_2 = \begin{vmatrix} 5+7j & 60.51-50.78j \\ -7j & -152 \end{vmatrix}$$

$$= -760 - 1.64j + 355.46 + 423.57j$$

$$\Delta_2 = -404.54 - 640.43j$$

$$I_1 = \frac{198.04 - 828.02j}{-27.3 - 29.5j} \Rightarrow 21.18\angle 56.28^\circ$$

$$I_2 = \frac{-404.54 - 640.43j}{-27.3 - 29.5j} \Rightarrow 18.8\angle 10.5^\circ$$

Power by Voltage Sources $P_1 = Re[V I_1^*]$

$$P_1 = Re\{(79\angle -40^\circ)(21.18\angle -56.23^\circ)\} \Rightarrow \boxed{P_1 = -181.577W}$$

$$P_2 = Re\{(152\angle 0^\circ)(18.8\angle -10.5^\circ)\} \Rightarrow \boxed{P_2 = 2809.74W}$$

Power by passive element

$$P_3 = |I_1|^2 R = 5 \times (21.18)^2 = 2376.2W$$

$$P_4 = Re\{V I^*\} = Re\{|I|^2 Z\} = Re\{(18.8)^2(-j3.1)\} = 0W$$

$$P_5 = Re\{(I_1 - I_2)^2 Z\}$$

$$= Re\{(15.68)^2 \times 7j\}$$

$$= 0W$$

Scanned with OKEN Scanner

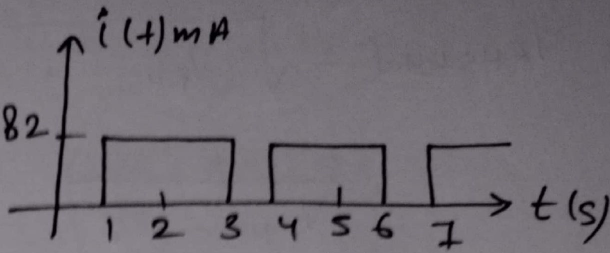
Q6. Compute the effective value of

(a) $i(t) = 3\sin 4t \ A$

(b) $v(t) = 4\sin 20t \cos 10t$

(c) $i(t) = 2 - \sin 10t \ mA$

(d) the waveform plotted in fig.



$$I_{rms} = \sqrt{\frac{1}{T}\int_0^T i^2(t)\,dt}$$

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T v^2(t)\,dt}$$

(a) $T = \frac{2\pi}{\omega} = \frac{2\pi}{4} = \pi/2$

$$I_{rms} = \sqrt{\frac{2}{\pi}\int_0^{\pi/2} (3\sin 4t)^2\,dt}$$

$$= \sqrt{\frac{2}{\pi}\int_0^{\pi/2} 9\sin 4t\,dt} \qquad \left[\because \cos 2A = 1 - 2\sin^2 A\right]$$

$$= 3\sqrt{\frac{\cancel{2}}{\pi}\int_0^{\pi/2} \frac{1}{\cancel{2}}(1 - \cos 8t.\,dt}$$

$$= 3\sqrt{\frac{1}{\pi}[t]_0^{\pi/2} - \cancel{\left[\frac{\sin 8t}{8}\right]_0^{\pi/2}} \to 0}$$

$$= 3\sqrt{\frac{1}{\cancel{\pi}}\left[\frac{\cancel{\pi}}{2}\right]_0^{\pi/2}} = \frac{3}{\sqrt{2}} = 2.12\ A$$

$$\boxed{I_{rms} = 2.12\ A}$$

(b) $v(t) = 4\sin 20t \ \cos 10t$

$2\sin A \cos B = \sin(A+B) + \sin(A-B)$

$v(t) = \frac{4}{2}(\sin 30t + \sin 10t)$

$$= 2(\underbrace{\sin 30t}_{①} + \underbrace{\sin 10t}_{②})$$

$V_{RMS_1} = \frac{2}{\sqrt{2}} = \sqrt{2}$, $V_{RMS_2} = \frac{2}{\sqrt{2}} = \sqrt{2}$

$V_{RMS total} = \sqrt{(V_{RMS_1})^2 + (V_{RMS_2})^2} = \sqrt{(\sqrt{2})^2 + (\sqrt{2})^2}$

$= \sqrt{4} = 2V$

$\boxed{V_{RMS} = 2V}$

(c) $i(t) = 2 - \sin(10t)\,mA$

$I_{RMS} = \sqrt{(\text{DC Value})^2 - \left(\frac{\text{AC sinusoidal}}{\sqrt{2}}\right)^2}$

$= \sqrt{(2)^2 + \left(\frac{1}{\sqrt{2}}\right)^2} = \sqrt{4+0.5} = \sqrt{4.5}$

$\boxed{I_{RMS} = 2.12\,mA}$

(d) $I_{rms} = \sqrt{\frac{1}{T}\int_0^T i^2(t)\,dt}$

$= \sqrt{\frac{1}{3}\int_1^3 i^2(t)\,dt}$

$= \sqrt{\frac{1}{3}\int_1^3 (2.82)^2\,dt}$

$= \sqrt{\frac{(2.82)^2}{3}\int_1^3 dt}$

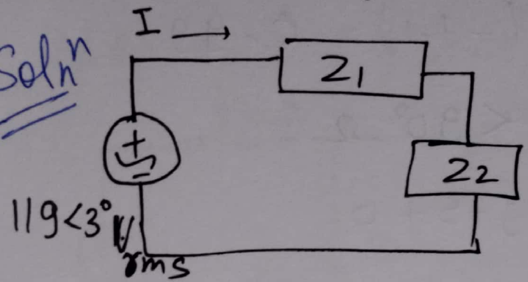
$= 2.82\sqrt{\frac{1}{3} \times (3-1)}$

$= 2.82\sqrt{\frac{2}{3}}$

$\boxed{I_{rms} = 2.30\,A}$

Q7 For the circuit of Fig. Compute the average power delivered to each load, the apparent power supplied by the source and the power factor of the combined loads if (a) $Z_1 = 14\angle 32^\circ \Omega$ and $Z_2 = 22\Omega$, (b) $Z_1 = 2\angle 0^\circ$ and $Z_2 = 6 - j\Omega$ (c) $Z_1 = 100\angle 70^\circ \Omega$ and $Z_2 = 75\angle 90^\circ \Omega$

Solⁿ



(a) $Z_1 = 11.87 + j\,7.41$

$Z_2 = 22 + j\,0$

Equivalent impedance $Z_{total} = Z_1 + Z_2 = 14\angle 32^\circ + 22\Omega$

$= 33.87 + j\,7.41$

$= 34.67\angle \underbrace{12.3}_{\theta_{total}}$

Current, $I_{rms} = \dfrac{V_{rms}}{Z_{total}} = \dfrac{119\angle 3^\circ}{(34.67\angle 12.3^\circ)}$

$= 3.42\angle -9.4^\circ \text{ A}$

Power delivered to each load

$P_1 = (I)^2 \, Re(Z_1) = (3.42)^2 . 11.87 \Rightarrow 138.8 \text{ W}$

$P_2 = |I|^2 \, Re(Z_2) = (3.42)^2 . 22 \Rightarrow 257.32 \text{ W}$

Apparant Supplied Power.

$S = |V_s| . |I| = (119)(3.42) = 406.98 \text{ VA}$

Power factor (Pf) $= \cos(\theta_{total}) = \cos(12.3) = 0.977$

(b) $Z_1 = 2\angle 0^\circ$, $Z_2 = 6 - j\Omega$

$Z_{total} = 2 + (6 - j) = 8 - j\Omega = 8.06\angle -7.1$

Current $\Rightarrow \dfrac{V_{rms}}{Z_{total}} = \dfrac{119\angle 3^\circ}{8.06\angle -7.1^\circ} \Rightarrow \boxed{I = 14.76\angle 10.1^\circ \text{A}}$

Power delivered to each load

$P_1 = |I|^2 \, Re(Z_1) = (14.76)^2 \, (2) = 435.7 \, W$

$P_2 = |I|^2 \, Re(Z_2) = (14.76)^2 \, (6) = 1307.14 \, W$

Apparant Power $(S) = |V_s||I| = (119)(14.76)$
$= 1756.44 \, VA$

Power factor $\Rightarrow PF = \cos(\theta_{total}) = \cos(-7.1) = 0.99$

(c) $Z_1 = 100 \angle 70° \, \Omega$ and $Z_2 = 75 \angle 90° \, \Omega$

$Z_1 = 34.2 + j\,93.97 \, \Omega$ $\qquad Z_2 = j75 + 0$

$Z_{total} = (34.2 + j93.97) + (j75) = 34.2 + j\,168.97 \, \Omega$

$Z_{total} = 172.3 \angle 78.5°$

Current $I = \dfrac{V_{rms}}{Z_{total}} = \dfrac{119 \angle 3°}{172.9 \angle 78.5} = 0.69 \angle -75.5° A$

Power delivered to each load

$P_1 = |I|^2 \, Re(Z_1) = (0.69)^2 (34.2) = 16.2 \, W$

$P_2 = |I|^2 \, Re(Z_2) = (0.69)^2 \, (0) = 0 \, W$

Apparant Power $S = |V_s||I| = (119)(0.69) = 82.11 \, VA$

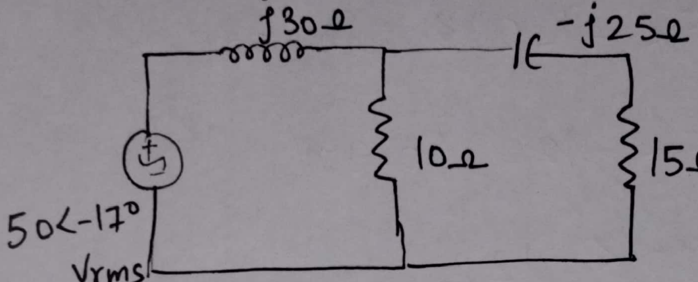
Power factor $(PF) = \cos(\theta_{total}) = \cos(78.5) = 0.19$

Q8. Replace the 10Ω resistor in the circuit of Fig. with a 200mH inductor assume an operating frequency of 10 rad/s and Calculate :

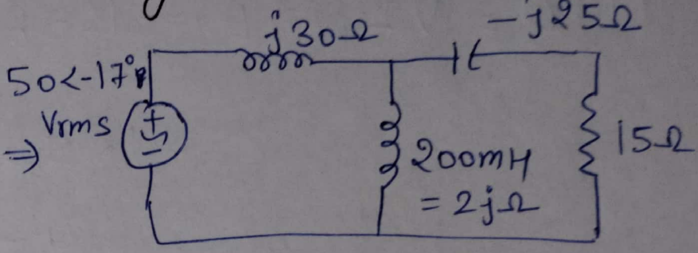
(a) the PF of the Source

(b) the apparent power supplied by the source.

(c) the reactive power delivered by the source.



⇒



$X_L = j\omega L$

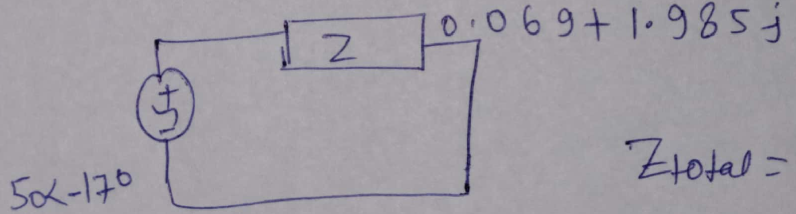
$= j \times 10 \times 200 \times 10^{-3}$

$= 2j\,\Omega$

$15 + (-j25) = 15 - j25$

Zequivalent $\Rightarrow \dfrac{1}{Z_{total}} = \dfrac{1}{30j} + \dfrac{1}{2j} + \dfrac{1}{(15-j25)}$

$$\boxed{Z_{eq} = 0.069 + 1.985j}$$



$Z_{total} = 1.986 \angle 88.0$

$I = \dfrac{V_{rms}}{Z_{total}} = \dfrac{50\angle -17°}{1.986 \angle 88}$

$$\boxed{I_{rms} = 25.17 \angle -105° A}$$

Scanned with OKEN Scanner

(a) Power factor (PF) = $\cos(\theta_{total}) = \cos(88)$

$= 0.0348$

(b) $|S| = VI = (50\angle-17^\circ)(25.17\angle-105^\circ)$

$= 1258.5\angle-122^\circ$

(c) $Q = VI \sin\theta = (1258.5\angle-122) \sin(88)$

$= 1258.5\angle-122\,(0.99)$

$Q = 1245.90\angle-122$