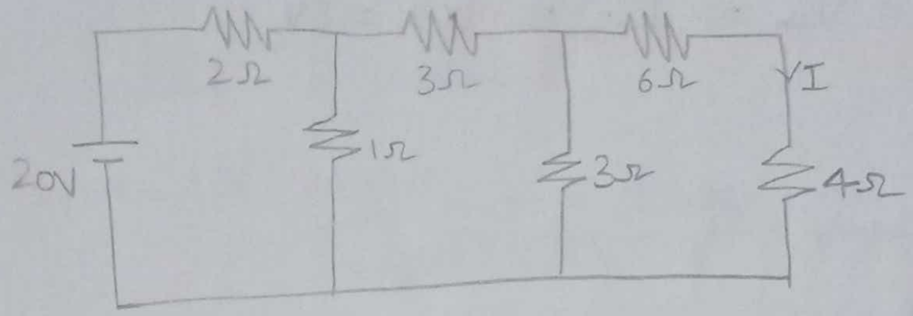
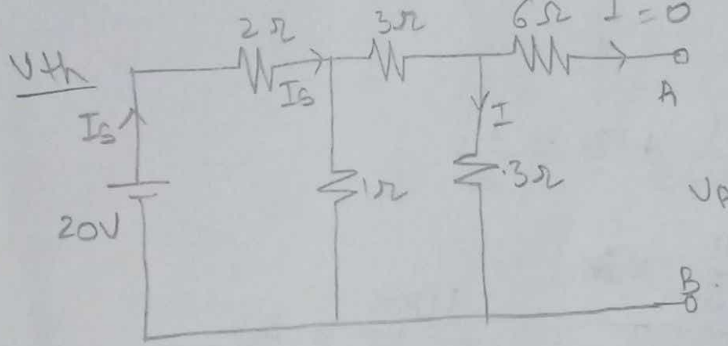
4. Find current flowing through 4 Ω resistor for the current shown in below figure using Thevenin's Theorem.



Sol



$V_{AB} = V_{OC} = V_{th}$

Applying KCL.

Method-1

$$\frac{V-20}{2} + \frac{V}{6} + \frac{V}{1} = 0$$

$$3V - 60 + V + 6V = 0$$

$$10V = 60$$

$$V = 6V$$

$$I = \frac{V}{6} = \frac{6}{6} = 1A$$

Method-2

$$\frac{6 \times 1}{7} = \frac{5}{7}$$

$$R_T = \frac{5}{7} + 2 = \frac{20}{7}$$

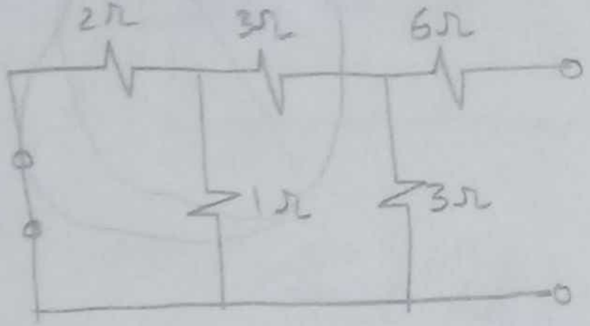
$$I_s = \frac{20}{20/7} = 7A$$

Current division

$$I_{6\Omega} = 7 \cdot \frac{1}{1+3+3} = 1A$$

$$V_{AB} = V_{th} = I \cdot 3 = 1 \times 3 = 3V$$

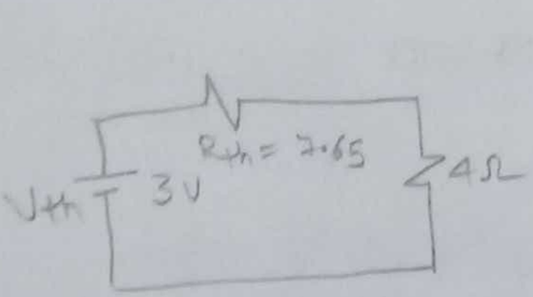
R_{th}



$$\frac{2 \times 1}{3} + 3 = \frac{11}{3}$$

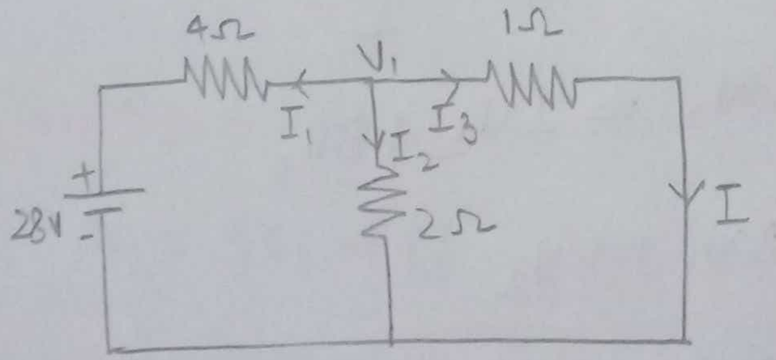
$$\frac{\frac{11}{\cancel{3}} \times \cancel{3}}{\frac{11}{3} + 3} = \frac{11 \times 3}{20} = \frac{33}{20}$$

$$R_{th} = \frac{33}{20} + 6 = \frac{153}{20} = 7.65\,\Omega$$



$$I = \frac{3}{7.65 + 4} = 0.257\,A$$

2. Prove reciprocity theorem for the given circuit



Sol Case ① Apply KCL at node ①

$$\frac{V_1-28}{4}+\frac{V_1}{2}+\frac{V_1}{1}=0$$

$$V_1-28+2V_1+4V_1=0$$

$$7V_1=28$$

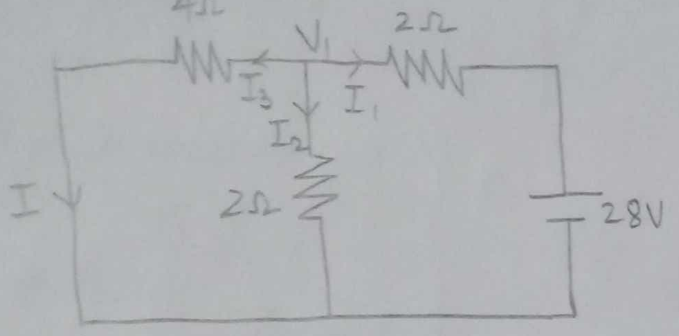
$$V_1=28/7$$

$$V_1=4V$$

$$I = \frac{V_1}{1}$$

$$I = \frac{4}{1} = 4A$$

Case ②



$$\frac{V_1 - 28}{1} + \frac{V_1}{2} + \frac{V_1}{4} = 0$$

$$4V_1 - 112 + 2V_1 + V_1 = 0$$

$$7V_1 = 112$$

$$V_1 = \frac{112}{7} = 16V$$

$$V_1 = 16V$$

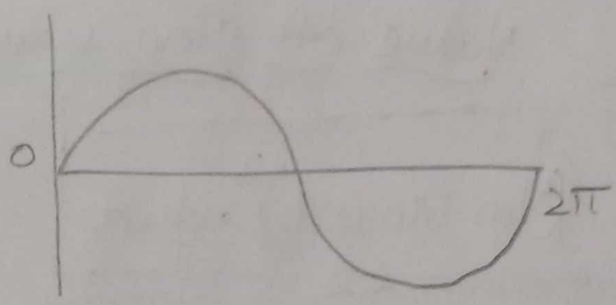
$$I = \frac{V}{R} = \frac{\cancel{16}\,4}{\cancel{4}\,1}$$

$$I = 4A$$

$$\therefore \frac{V_a}{i_b} = \frac{V_a}{i_b}$$ ∴ Hence reciprocity is verified

$$\therefore \frac{28}{4} = \frac{28}{4}$$

Average Value of AC Voltage



$$\boxed{V_{avg} = \frac{1}{T}\int_0^T V_m \sin \omega t \cdot d\omega t}$$

(or)

Time period $= 2\pi$ $\longrightarrow$ $V_{avg} = \text{total Area} / 2\pi = 0$

$$V_{avg} = \frac{1}{2\pi}\int_0^{2\pi} V_m \sin \omega t \cdot d\omega t$$

For complete Sine Wave form, $V_{avg} = 0$

Therefore, consider average value of one half cycle.

$$V_{avg} = \frac{1}{T/2}\int_0^{T/2} V_m \sin\omega t \cdot d\omega t$$

$$V_{avg} = \frac{1}{\pi}\int_0^{\pi} V_m \sin\omega t \cdot d\omega t$$

$$V_{avg} = \frac{V_m}{\pi}\left[-\cos\omega t\right]_0^{\pi}$$

$$V_{avg} = -\frac{V_m}{\pi}\left[\cos\pi - \cos 0\right]$$

$$V_{avg} = -\frac{V_m}{\pi}\left[-1-1\right]$$

$$V_{avg} = -\frac{V_m}{\pi}(-2)$$

$$\boxed{V_{avg} = \frac{2V_m}{\pi}}$$

Root Mean Square Value of sine wave form

$$\boxed{V_{rms} = \sqrt{\frac{1}{T}\int_0^T (V_m \cdot \sin\omega t)^2 \cdot d\omega t}}$$

$$= \sqrt{\frac{1}{2\pi}\int_0^{2\pi} V_m\left(\frac{1-\cos 2\omega t}{2}\right) d\omega t} \quad \left\{\begin{array}{l}\cos 2\omega t = 1-2\sin^2\omega t \\ \sin^2\omega t = \frac{1-\cos 2\omega t}{2}\end{array}\right.$$

$$V_{rms} = \sqrt{\frac{V_m^2}{4\pi}\int_0^{2\pi}(1-\cos 2\omega t)\, d\omega t}$$

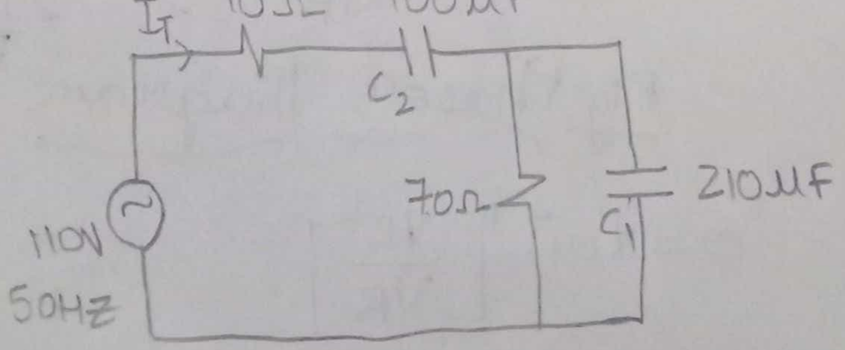
$$= \sqrt{\frac{V_m^2}{4\pi}\left[\omega t - \frac{\sin 2\omega t}{2}\right]_0^{2\pi}}$$

$$= \sqrt{\frac{V_m^2}{\cancel{2\pi}\;2} \cdot \cancel{2\pi}}$$

$$\boxed{V_{rms} = \frac{V_m}{\sqrt{2}}}$$

* Mid

1. Determine total impedence, total current, Phase angle for the Circuit shown below.



Sol:

$V_{rms} = 110V$

$f = 50Hz$

$$X_{C_1} = \frac{-j}{\omega C_1}$$

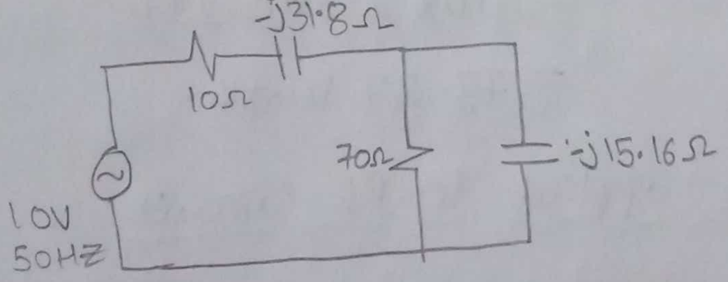
$$= \frac{-j}{2\pi(50)\,210\times10^{-6}}$$

$$= \frac{-j10^6}{314\times210} = -j15.16\,\Omega$$

$$X_{C_2} = \frac{-j}{\omega C_2}$$

$$= \frac{-j}{2\pi(50)\,100\times10^{-6}}$$

$$= \frac{-j\times10^6}{2\pi(50)\times100} = -j31.8\,\Omega$$



$$Z_2 = \frac{70\times -j15.16}{70 - j15.16}$$

$$Z_2 = \frac{70\times 15.16\angle -90}{\sqrt{70^2+15.16^2}\angle\tan^{-1}\left(\frac{-15.16}{70}\right)}$$

$$Z_2 = 14.81\angle -90 + 12$$

$Z_2 = 14.81\angle -78 \rightarrow$ Polar form

$Z_2 = 14.81\cdot\cos78 - j14.81\sin78$

$Z_2 = 3.06 - j14.48$

$Z_1 = 10 - j318$

$Z_T = Z_1 + Z_2$

$= 10 - j318 + 3.06 - j14.48$

$= 13.06 - j45.54$

$= \sqrt{13.06^2 + 45.5^2} \angle -\tan^{-1}() = 47.3 \angle -73$

$I_T = \dfrac{110}{47.3 \angle -73} = 2.3 \angle 73$

Phase angle $\theta = 73^\circ$ leading

Power factor $= \cos\theta$

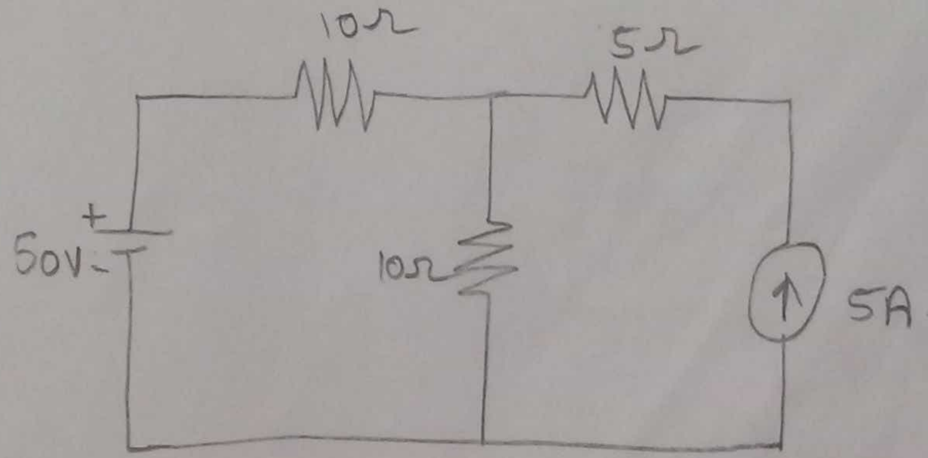
$= \cos 73^\circ = 0.29$ Leading

Active power $= VI\cos\theta$

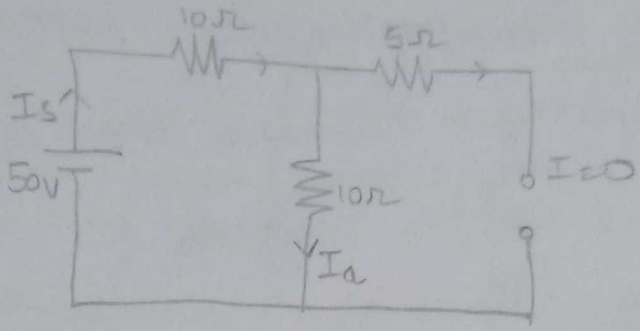
$= 110 \times 2.3 \times (0.29)$

$= 73.37$ Watts.

2. Find current through 5Ω resistor using super position theorem.



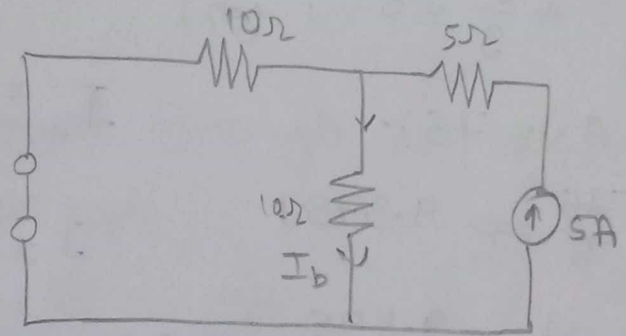
Sol case i) While 50V source acting alone



$$I_s = \frac{50}{10+10} = 2.5A$$

$I_a = 2.5A$

Case ii) while 5A source acting alone



$$I_b = \frac{5 \cdot 10}{10+10} = 2.5A$$

$I_1 = I_a + I_b$

$I_1 = 5A$

find current in various branches

$I_{5A} = 5A$

Emf equation of Transformer

let $\phi = \phi_m \sin \omega t$

According to faraday's law

(Induced emf) $E = \frac{-N d\phi}{dt}$

$$E = -N \frac{d \phi_m \sin \omega t}{dt}$$

(Instantaneous Induced Emf) $E = -N \omega \phi_m \cos \omega t$

$$E = N\omega\phi_m \sin(\omega t - \pi/2) = E_m \sin(\omega t - \pi/2)$$

For Rms Induced Emf $= \frac{N\omega\phi_m}{\sqrt{2}}$

$$= \frac{N 2\pi f \phi_m}{\sqrt{2}}$$

$E_{1rms} = 4.44 f \phi_m N_1 \Rightarrow E_1$

$E_{2rms} = 4.44 f \phi_m N_2 \Rightarrow E_2$

$$\boxed{\frac{E_1}{E_2} = \frac{N_1}{N_2}}$$