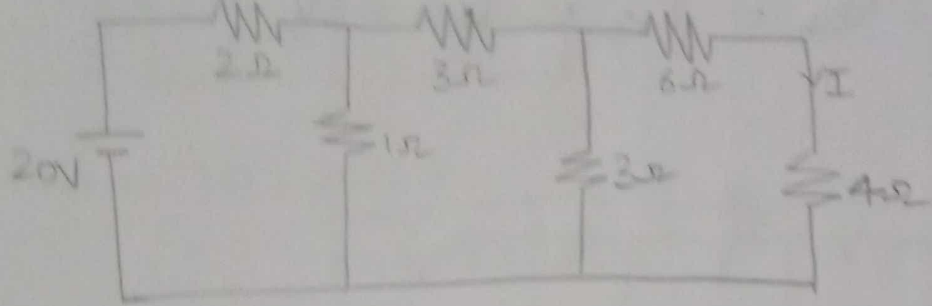
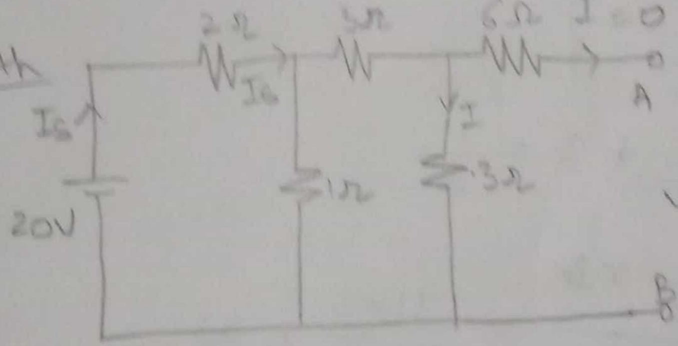
4. Find current flowing through 4 Ω resistor for the current shown in below figure using Thevenin's Theorem.



Sol

Vth



$V_{AB} = V_{oc} = V_{th}$

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

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

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

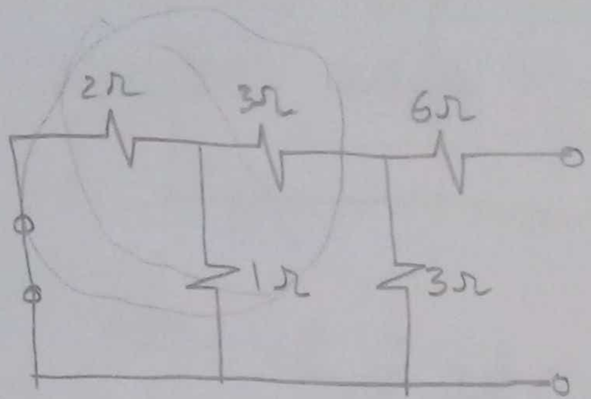
$$I_s = \frac{20}{20/7} = 7A$$

Current division

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

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

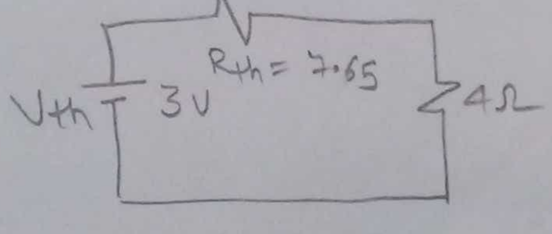
Rth



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

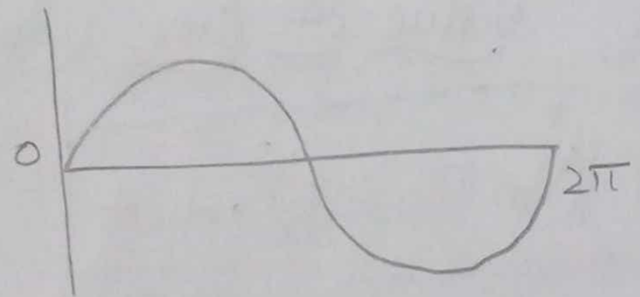
$$\frac{\frac{11}{\cancel{3}} \times \cancel{3}}{\frac{11}{3} + 3} = \frac{11 \times 3}{20} = \frac{33}{20}$$

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



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

Average Value of AC Voltage by analytical Method



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

(or) $\longrightarrow$ $V_{avg} = \text{total Area} \big|_{2\pi} = 0$

Time period $= 2\pi$

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

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

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

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

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

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

$$= \sqrt{\frac{V_m^2}{\cancel{4\pi}_{2}} \cdot \cancel{2\pi}_{1}}$$

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

Ideal Transformer

Definition: The transformer which is free from all types of losses is known as an ideal transformer. It is an imaginary transformer that has no core loss, no ohmic resistance, and no leakage flux. The ideal transformer has the following important characteristic.

1. The resistance of their primary and secondary winding becomes zero.
2. The core of the ideal transformer has infinite permeability. The infinite permeable means less magnetizing current requires for magnetizing their core.
3. The leakage flux of the transformer becomes zero, i.e. the whole of the flux induces in the core of the transformer links with their primary and secondary winding.
4. The ideal transformer has 100 percent efficiency, i.e., the transformer is free from hysteresis and eddy current loss.

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 $= \frac{N \omega \phi_m}{\sqrt{2}}$

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

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

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

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