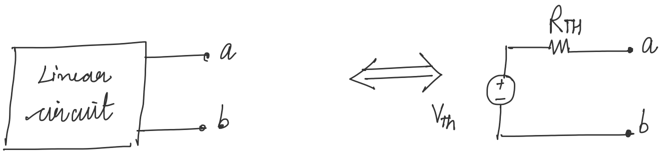
Lecture 5

Friday, 19 January 2024 3:33 PM

* Thevenin equivalent :-

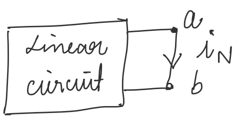
- Any linear circuit can be represented by a Thevenin equivalent circuit.



- To find V_{Th} find voltage at terminals ab
- To find R_{th} turn off all the independent sources and find equivalent impedance.
- If there are dependant sources in circuit, R_{th} can be found out by connecting a hypothetical 1V supply across ab & find find the current drawn by the circuit from the 1V source

$$R_{th} = \frac{V_{ab}}{i}$$

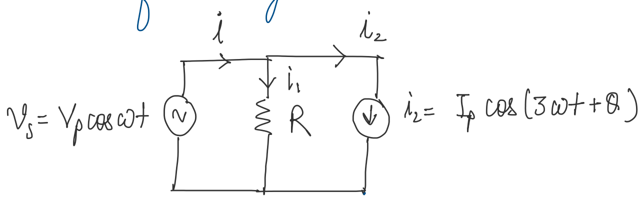
- Another way to find R_{th} is by finding the Norton current by shorting ab and finding i_N



$$R_{th} = \frac{V_{Th}}{i_N}$$

* Distortion reactive power :-

Consider the following circuit :-



$$i_1 = \frac{v_s}{R} = \frac{V_p}{R} \cos(\omega t)$$

$$i = i_1 + i_2 = \frac{V_p}{R} \cos(\omega t) + I_p \cos(3\omega t + \theta)$$

$$i_{RMS} = \left\{ \frac{1}{2\pi} \int_0^{2\pi} \left(\frac{V_p}{R} \cos(\omega t) + I_p \cos(3\omega t + \theta) \right)^2 d(\omega t) \right\}^{1/2}$$

$$= \left\{ \frac{1}{2\pi} \int_0^{2\pi} \left[\frac{V_p^2}{R^2} \left(\frac{\cos 2\omega t + 1}{2} \right) + I_p^2 \left(\frac{\cos(6\omega t + 2\theta) + 1}{2} \right) + \frac{V_p I_p}{R} \left(\cos(4\omega t + \theta) + \cos(2\omega t + \theta) \right) \right] d\omega t \right\}^{1/2}$$

$$= \left\{ \frac{1}{2\pi}\left(\frac{V_p^2}{R^2 \times 2} \times 2\pi + \frac{I_p^2}{2} \times 2\pi \right) \right\}^{1/2}$$

$$i_{RMS} = \sqrt{\frac{V_p^2}{2R^2} + \frac{I_p^2}{2}}$$

Apparent power supplied by the voltage source

$$S = V_{rms} I_{rms}$$ → Total power delivered by the source.

$$S = V_{rms} \times \left[\frac{V_{rms}^2}{R^2} + \frac{I_p^2}{2} \right]^{1/2}$$

Average power supplied by voltage source

$$P = \frac{1}{2\pi} \int_0^{2\pi} V_p \cos(\omega t) \left[\frac{V_p}{R} \cos(\omega t) + I_p \cos(3\omega t + \theta) \right] d\omega t \rightarrow \int (VI)_{instantaneous}$$

$$= \frac{1}{2\pi} \int_0^{2\pi} \left[\frac{V_p^2}{R} \left(\frac{\cos 2\omega t + 1}{2} \right) + V_p I_p \frac{1}{2} \left[\begin{matrix} \cos(2\omega t + \theta) \\ + \cos(4\omega t + \theta) \end{matrix} \right] \right] d\omega t$$

$$= \frac{1}{2\pi} \frac{V_p^2}{2R} \times 2\pi$$

$$P = \frac{V_p^2}{2R} = \frac{V_{rms}^2}{R}$$

$$\text{Now power factor} = \frac{P}{S} = \frac{\frac{V_{rms}^2}{R}}{V_{rms} \left[\frac{V_{rms}^2}{R^2} + \frac{I_p^2}{2} \right]^{1/2}}$$

$$= \frac{V_{rms}/R}{\left[\frac{V_{rms}^2}{R^2} + \frac{I_p^2}{2} \right]^{1/2}}$$

- Average power supplied by the voltage source is only because of the resistor branch.
- There is no real power drawn by the current source with different frequency than the voltage source.
- The current source of different frequency draws some reactive power known as distortion reactive power. Due to this reactive power there is increase in I_{RMS} supplied by the voltage source. The increased I_{RMS} leads to additional losses in the transmission line. The distortion reactive power is to account

for the losses due to current i_2

distortion reactive power in the above circuit can be given by $Q = \sqrt{S^2 - P^2}$