• Network theory - DAY 02

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#ALI8ECO05

→ Introduction to Network theorems:

There are 9 theorems in N/w theorems.

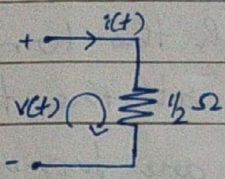
• Linearity Property: It is property of an element describing a linear relationship b/w the i/p & o/p.

It is the combination of two laws:

(i) Law of Homogeneity.

(ii) Law of Additivity.

Ex: $i(t) = 2v(t)$



$+v(t) - \frac{i(t)}{2} = 0 \Rightarrow i(t) = 2v(t)$. , LOH: $v(t) \rightarrow S \rightarrow i(t) = 2v(t)$

$\downarrow \times a$

$i(t) = 2av(t)$

$v(t) \xrightarrow{\times a} av(t) \rightarrow S \rightarrow 2av(t)$ (same)

LOA : $v_1(t) \rightarrow S \rightarrow i_1(t) = 2v_1(t)$

$v_2(t) \rightarrow S \rightarrow i_2(t) = 2v_2(t)$

$+ = 2v_2(t) + 2v_2(t)$

$v_1(t) + v_2(t) \rightarrow S \rightarrow i'(t) = 2v_2(t) + 2v_2(t)$

The system is Linear.

• **Superposition theorem:** The voltage across (or current through) an element in a linear circuit is the algebraic sum of the voltages across (for current through) that element due to each independent source acting alone.

Turned off: It means all the independent sources are replaced by their internal resistances. i.e we replace every voltage source by 0V, and every current source by 0A.

→ The dependent sources are left as they are.

→ The superposition theorem is not valid in case of non-linear circuits.

• **Thevenin's theorem:** A linear and bidirectional two terminal n/w can be replaced by an equivalent n/w consisting of a voltage source V_{TH} connected in series with a resistor R_{TH}.

V_{th} - Open ckt voltage at the terminals.

R_{th}: Input/Equivalent resistance at the terminals when the independent sources are turned off.

3. **Norton's theorem**: A linear and bidirectional two-terminal n/w can be replaced by an equivalent circuit consisting of a current source I_N in parallel with a resistor R_N."

I_N: Short ckt current through the terminals.

R_N: Input/Equivalent resistance at the terminals when the independent sources are turned off.

$R_N = R_{TH}$

$I_N = \frac{V_{TH}}{R_{TH}}$, $R_{TH} = \frac{V_{TH}}{I_N}$ $\Rightarrow R_{TH} = R_N = \frac{V_{TH}}{I_N}$

Source trans

Source transformation called Thevenin-Norton transformation.

4. **Reciprocity theorem**: In a linear bidirectional single source n/w the ratio of response to excitation remains the same even when the positions of response & excitation are interchanged":

1) The ratio of response to excitation is either ohm or Mho.

2) Only one independent source is present in the ckt., No dependent source is present in the ckt.

- **Millman's theorem**: If n voltage source with voltage $E_1, E_2, E_3 \ldots E_n$ and internal resistance $R_1, R_2, R_3, \ldots R_n$ are connected in parallel then these voltage sources can be replaced by a single source E in series with resistance R.

$I_N = E_1/R_1 + E_2/R_2 + \ldots + E_n/R_n$, $R_N = R_1 \| R_2 \| \ldots \| R_n$.

$1/R_N = 1/R_1 + 1/R_2 + \ldots + 1/R_n$

$$E = \frac{\sum_{i=1}^{n} E_i G_i}{\sum_{i=1}^{n} G_i}, \quad R = R_n.$$

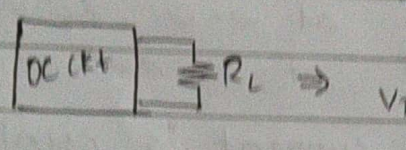
5) $I = \frac{I_1R_1 + I_2R_2 + \dots I_nR_n}{R_1 + R_2 + \dots R_n}$.

$I = \frac{\sum_{i=1}^{n} I_i R_i}{\sum_{i=1}^{n} R_i}$ $\quad R = R_1 + R_2 + \dots + R_n$

$R = \sum_{i=1}^{n} R_i$.

- **Maximum Power Transfer theorem for DC circuits:**

Maximum power will be transferred to the load when the value of load resistance is equal to the thevenin's equivalent resistance of the ckt.



$I = \frac{V_{TH}}{R_{TH}+R_L}$, $P = I^2R_L$

$P = \left(\frac{V_{TH}}{R_{TH}+R_L}\right)^2 R_L$

$\frac{dP}{R_L} = 0 \Rightarrow \frac{dP}{R_L} = \frac{V_{TH}^2[(R_{TH}+R_L)^2 - 2R_L(R_L+R_{TH})]}{(R_{TH}+R_L)^4} = 0$

$\boxed{R_L = R_{TH}}$ where maximum amount of power to load resistance.

- **Compensation Theorem:** I and the resistance of any branch of a N/w is changed from R to (R+ΔR) where the current was originally I, then the change of current at any point in the n/w may be calculated by assuming than an e.m.f - IΔR has been introduced into the modified branch while all other sources have their e.m.f's suppossed and are represented by their internal resistances only.

Application: ① This theorem is useful to calculate the sensitivity of electrical n/w and bridges.

② It is useful in potentiometer ckt.

- **Tellegens Theorem:** States if we have n elements in a ckt and the instaneous voltage the elements are $V_1, V_2, \dots V_n$ and they will satisfy $I<V_L$.

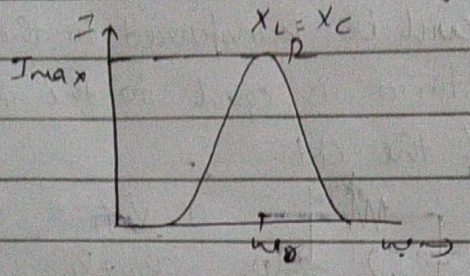
and instantaneous current which obeys KCL.

$\Sigma P = 0$

$\Sigma P_{supplied} = \Sigma P_{absorbed}$, $P = I^2R = \frac{V^2}{R}$.

- **Series Resonance in R-L-C circuits:**

Resonance: It is phenomenon at which the response of the ckt is max. for a particular frequency.



$X_L = \omega L$

$X_C = 1/\omega C$

at $\omega = 0$, $X_C = \infty$

at $\omega = \infty$, $X_L = \infty$

- At lower end the current is minimum.
  At upper end the current is maximum, $X_L = X_C$
  It is used in radio communication for selecting channel.

$Q = 2\pi \times \frac{\text{Maximum Energy stored}}{\text{Energy dissipated}}$.

Bandwidth = The difference b/w half power freq.

$B.W = f_2 - f_1 = \omega_2 - \omega_1$, $f = \frac{1}{2\pi\sqrt{LC}}$

Impedance $\Rightarrow Z = R$ (Minimum).

Bandwidth $\Rightarrow BW = R/L$.

Q.F $\Rightarrow Q = \omega L/R = 1/\omega CR$.

Resonant Frequency $\Rightarrow \omega = 1/\sqrt{LC}$.

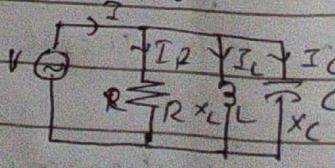
$I = V/R$ (maximum).

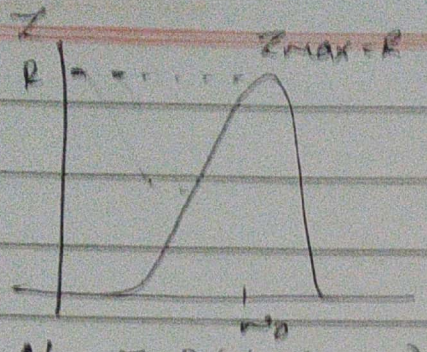
- ~~Seri~~ Resonance in Parallel R-L-C circuit.

$X_L = X_C$, Voltage & current are in phase.

Impedance is max.

Current is Minimum.





$\omega=0 \Rightarrow X_L=0$

$\omega=\infty \Rightarrow X_C=1/\omega C=0$.

$Z_{max}=R$.

At $Z=R$ (Maximum)	Impedance.
Bandwith	$BW=1/RC$
Q.F	$Q=\omega RC$
Resonant frequency	$\omega=1/\sqrt{LC}$
Current	$I=V/R$ (Minimum).

- Python: Scrape Real Estate property.
  Data from the web.
  - Learnt about scraped website data - how the o/p will look like.
  - Learnt about leading the webpage in python.
  - How to Extracting div Tags.
  - Extracting addresses and property details.
  - Extracting Elements without unique identities.
  - Saving the Extracted Data in csv files.
  - Traveling through webpage.