Thevenin's Theorem :- for independent & dependent sources with control variable not part of ckt as usual. whereas for dependent source with controlling variable part of the ckt (i) V_{oc} I_{sc} gives Z_{int} (ii) a voltage is applied across load open such that it sends unity current then Z_{int} = Vapplied.

Superposition Theorem :- for networks where both independent and dependent sources exist, the superposition theorem is applied for each independent source & each dependent source not having a controlling variable part of ckt, the dependent source which have control variable part of the ckt is not considered also this dependent source is not neglected while considering other sources.

Compensation Theorem :-

$$\Delta I = \frac{-V_c}{R_{Th} + R_L + \Delta R}$$

where $V_c = \Delta R \, I$

Tellegen's Theorem :- $\sum_{b=1}^{b} V_b i_b = 0$

Max Power Theorem :- $Z_L = Z_{int}$

$$P_{max} = \frac{V_{oc}^2}{4R_L}$$

Reciprocity Theorem :- If a voltage applied in one branch produces & current in other branch then the ratio of V/I remains same if we interchange the position of applied voltage and current measured.

Unit III :- Fourier series

① Exponential form

$$f(t) = \sum_{n=-\infty}^{\infty} C_n e^{jn\omega t} dt$$

$$\& \; C_n = \frac{1}{T} \int_0^T f(t) e^{-jn\omega t} dt$$

② **Trigonometric form** :-

$$f(t) = a_0 + \sum_{n=1}^{\infty} (a_n \cos nx + b_n \sin nx)$$

$$a_0 = \frac{1}{T} \int_0^T f(t) dt$$

$$a_n = \frac{2}{T} \int_0^T f(t) \cos n\omega t \, d\omega t$$

$$b_n = \frac{2}{T} \int_0^T f(t) \sin n\omega t \, d\omega t$$

Relation b/w Exp & Trigo coffts :-

$a_0 = C_0$, $a_n = C_n + C_{-n}$ & $b_n = j(C_n - C_{-n})$

3) Even function symmetry:-

when $f(-t) = f(t)$ then even symm

and $a_0 = \frac{2}{T}\int_0^{T/2} f(t)\, dt$

$a_n = \frac{4}{T}\int_0^{T/2} f(t) \cos n\omega t\, dt$

$b_n = 0$

④ Odd function symmetry:-

when $f(-t) = -f(t)$ then odd function symm

and $a_0 = 0$

$a_n = 0$

$b_n = \frac{4}{T}\int_0^{T/2} f(t) \sin n\omega t\, dt$

⑤ Half wave symmetry:-

when $f(t - T/2) = -f(t)$ then Half wave symmetry i.e. any half cycle is inverted version of adjacent half cycle.

and $a_0 = a_n = b_n = 0$ for n even

$a_n = \frac{4}{T}\int_0^{T/2} f(t) \cos n\omega t\, d\omega t$ for n odd

$b_n = \frac{4}{T}\int_0^{T/2} f(t) \sin n\omega t\, d\omega t$ for n odd

Discrete spectrum :- plot of amplitude of harmonics V/s freq.

Average :- $\frac{1}{T}\int_0^T f(t)\, dt$

RMS :- $\sqrt{\frac{1}{T}\int_0^T f^2(t)\, dt}$

for $e = E_0 + E_{max1}\sin(\alpha + \phi_1) + E_{max2}\sin(2\alpha + \phi_2)$
$+ \cdots + E_{maxn}\sin(n\alpha + \phi_n)$ --- (1)

$\therefore E_{rms} = \sqrt{E_0^2 + E_1^2 + E_2^2 + \cdots + E_n^2}$

where $E_1 = E_{max1}/\sqrt{2}$, $E_2 = E_{max2}/\sqrt{2}$ & so on

suppose
$i = I_0 + I_{max1}\sin(\alpha + \phi_1 + \psi_1) + I_{max2}\sin(2\alpha + \phi_2 + \psi_2)$
$+ \cdots + I_{maxn}\sin(n\alpha + \phi_n + \psi_n)$

then average power

$P = E_0 I_0 + \frac{E_{max1} I_{max1}}{2}\cos\psi_1 + \frac{E_{max2} I_{max2}}{2}\cos\psi_2$
$+ \cdots + \frac{E_{maxn} I_{max}}{2}\cos\psi_n$

$= E_0 I_0 + E_1 I_1 \cos\psi_1 + E_2 I_2 \cos\psi_2 + \cdots$
$\cdots + E_n I_n \cos\psi_n$

Discrete spectrum :- plot of amplitude of harmonics v/s freq

Average :- $\frac{1}{T}\int_0^T f(t)\, dt$

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then average power

$$P = E_0 I_0 + \frac{E_{max1} I_{max1}}{2}\cos\psi_1 + \frac{E_{max2} I_{max2}}{2}\cos\psi_2 + \cdots + \frac{E_{maxn} I_{maxn}}{2}\cos\psi_n$$

$$= E_0 I_0 + E_1 I_1 \cos\psi_1 + E_2 I_2 \cos\psi_2 + \cdots + E_n I_n \cos\psi_n$$

Fourier Transform / continuous spectrum

Fourier Transform of function $f(t)$ is ~~deno ded as F(j)~~ denoted as $F(j\omega)$ & given by $F(j\omega) = \int_{-\infty}^{\infty} f(t)\, e^{-j\omega t}\, dt$

FT of Impulse function $\delta(t)$:-

$$F(j\omega) = \int_{-\infty}^{\infty} \delta(t)\, e^{-j\omega \times 0}\, dt = \int_{-\infty}^{\infty} \delta(t)\, dt .\, e^{0}$$

$$= 1 . 1 = 1$$

FT of gate ~~const~~ function :- $f(t) = A, \; -\frac{T}{2} < t < \frac{T}{2}$
$= 0, \; |t| > T/2$

$$F(j\omega) = AT \frac{\sin \omega T/2}{\omega T/2}$$

FT of const function :- $f(t) = A, \; -\infty < t < \infty$

$f(t)$ not integrable since limits are not finite, it can be evaluated as limiting value of FT of gate function.

$f(t) = \lim_{T \to \infty} [G(t)]$

then $F(j\omega) = \lim_{T \to \infty} AT \frac{\sin \omega T/2}{\omega T/2}$

$\therefore F(j\omega) = 2\pi A\, \delta(\omega)$

$\delta(\omega) = \lim_{T \to \infty} \frac{\sin \omega T/2}{\omega T/2}$

$= 1$

as $T \to \infty, \omega \to 0$

$\therefore \delta(\omega) = \lim_{T \to \infty} \frac{\sin 0}{0}$

FT of signum function :- signum function is defined as
$sgn(t)$

$$f(t) = 1 \quad ; \quad t > 0$$
$$= -1 \quad ; \quad t < 0$$

It is not absolutely integrable its FT can be evaluated as limiting value of FT of an exponential function, thus

$$f(t) = \lim_{a \to 0} \begin{cases} e^{-at} & ; \ t > 0 \\ -e^{at} & ; \ t < 0 \end{cases}$$

$$\therefore F(j\omega) = \lim_{a \to 0} \left[-\int_{-\infty}^{0} e^{at} e^{-j\omega t} dt + \int_{0}^{\infty} e^{-at} e^{-j\omega t} dt \right]$$

$$= -\frac{2j}{\omega} = \frac{2}{j\omega}$$

FT of unit step function :-

$$u(t) = 1 \quad ; \quad t \geq 0$$
$$= 0 \quad ; \quad t < 0$$

not absolutely integrable can be seen as

$$sgn(t) = 2u(t) - 1$$

or $u(t) = \frac{1}{2}\{sgn(t) + 1\}$

$$FT[u(t)] = \frac{1}{2} FT[sgn(t)] + \frac{1}{2} FT[1]$$
$$= \frac{1}{2}\left(\frac{-2j}{\omega}\right) + \frac{1}{2}[2\pi\,\delta(\omega)]$$

$$\therefore F(j\omega) = \frac{1}{j\omega} + \pi\,\delta(\omega)$$

Properties of FT :-