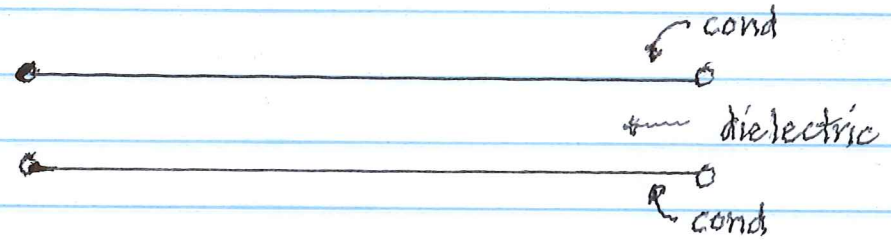
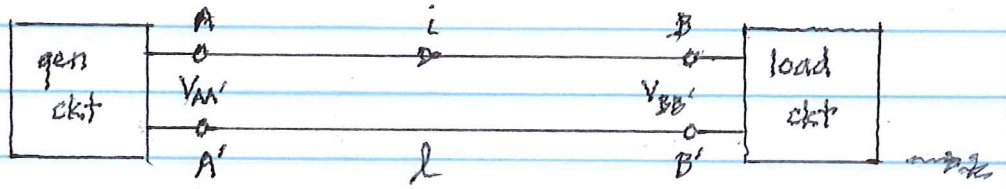
EE 331 - LECT. #5 JAN. 24, 2020

ch. 11 - transmission lines (TLs)

we represent any two-conductor TL schematically by:



in ckts, you considered the following set-up:



we connected a TL btwn gen ckt & load ckt & then we ignored it. when can you ignore TL & when can't you?

suppose:

$$V_{AA'} = V_0 \cos(\omega t)$$

what is $V_{BB'}$?

$$V_{BB'} = V_0 \cos\{\omega(t - \ell/u)\}$$
$$= V_0 \cos(\omega t - \beta\ell)$$

ℓ = length of TL [m]
u = wave velocity [m/s]
β = phase const [rad/m]

consider:

$l = 2.5$ cm $(\sim 1$ in$)$ = length of TL

$f = 2$ kHz

$u = c = 3 \times 10^8$ m/s

$\beta = \omega/u$ rad/m

let $t = 0$. then

$$V_{AA'} = V_0$$

$$V_{BB'} = V_0 \cos(2\pi f l/u)$$

$$= 0.999999999999945 V_0 \approx V_0$$

12 9's

seems okay to ignore TL.

consider:

$l = 10$ km $= 6.2$ mi

$f = 2$ kHz

$u = c = 3 \times 10^8$ m/s

find

$$V_{BB'} = V_0 \cos(\beta l) = V_0 \cos(2\pi f l/u)$$

$$= 0.9135 V_0$$

POTS (plain old telephone svc) $\sim$ 300 - 3.4 kHz

seems that we shouldn't ignore TL.

what's the difference? only ℓ, but relative to what? the wavelength.

in em, λ is an important concept. "define" problems by relative size of wavelength.

high freq problem: $\lambda \ll$ object
low freq problem: $\lambda \gg$ object

$$\lambda = 2\pi/\beta \quad , \quad \beta = \omega/u = 2\pi f/u$$

$$\rightarrow \lambda = u/f \rightarrow 1/\lambda = f/u$$

recall,

$$\beta\ell = 2\pi\ell f/u = 2\pi \ell/\lambda$$

$$\cos\{\beta\ell\} = \cos\{2\pi \ell/\lambda\}$$

rules of thumb:

$\ell/\lambda \ll 1 \rightarrow$ ignore TL

$\ell/\lambda \gtrsim 0.01 \rightarrow$ may not be able to ignore TL.