APPENDIX C

Brief Discussion of Underground Cables

- Used as a means of transmission & distribution of electric power, especially in thickly-populated urban areas (e.g. Singapore)

- Generally more expensive to install cables (as opposed to lines)

- Cables consist of 3 basic elements :

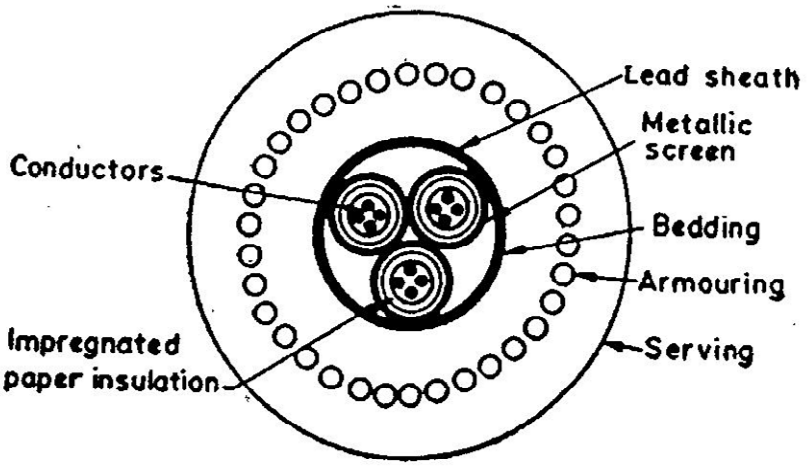
    1) Conductor for power transmission (copper, aluminum : usually stranded)

    2) Insulation to isolate conductor from ground & other objects (resistance of insulation very high $\geq$ 1 MΩ to avoid leakage current)

        – Insulation commonly called dielectric e.g. rubber, polyethylene, PVC, paper, mineral, etc.

    3) Mechanical protection against damage

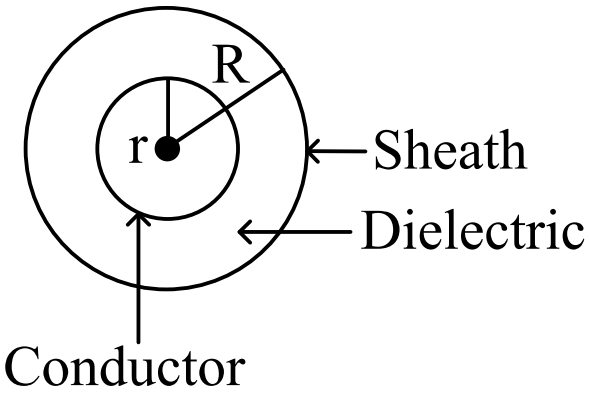
        – In the form of mild steel-tape armouring or galvanized wire armouring.



Typical 3-core cable

- Cables specified by capacitance due to close proximity of conductors & the dielectric between conductors.

Single-core cable : Let conductor radius = r & sheath radius = R



Cable capacitance : $C = \frac{2\pi\varepsilon}{\ln\left(\frac{R}{r}\right)}$ F/m

where : $\varepsilon = \varepsilon_o \varepsilon_r$ (ε : dielectric constant of insulation

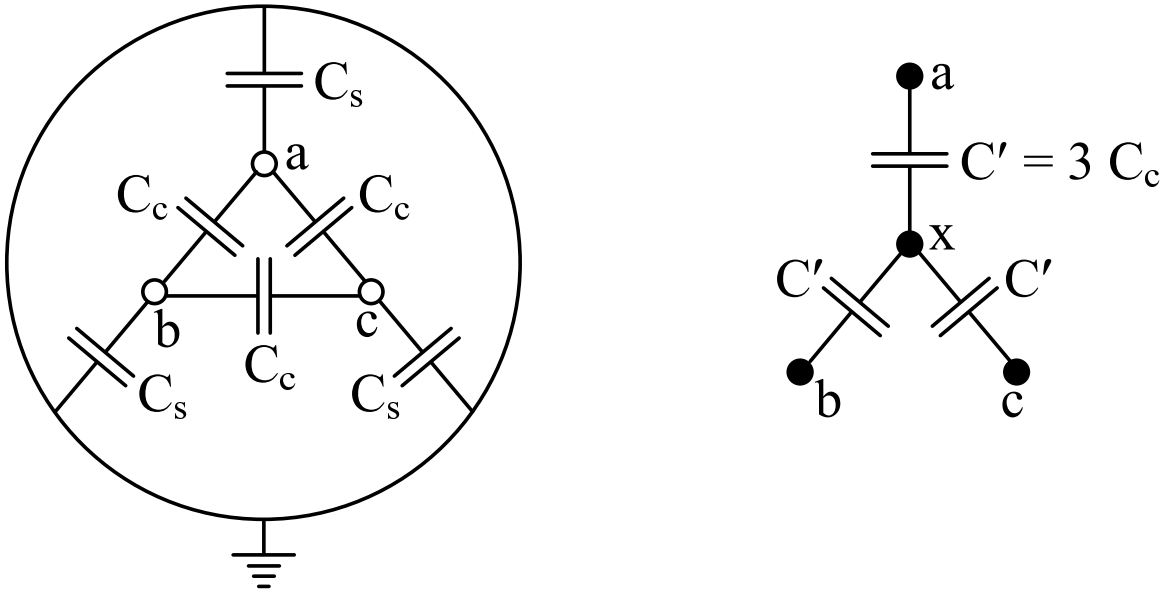
ε_o : 8.842×10^{-12}

ε_r : relative permittivity of insulating material)

<u>Three-core cables</u> : A 3-core (conductor) cable has

(i) capacitances between its cores (C_c), and
(ii) capacitances between each core & sheath (C_s).

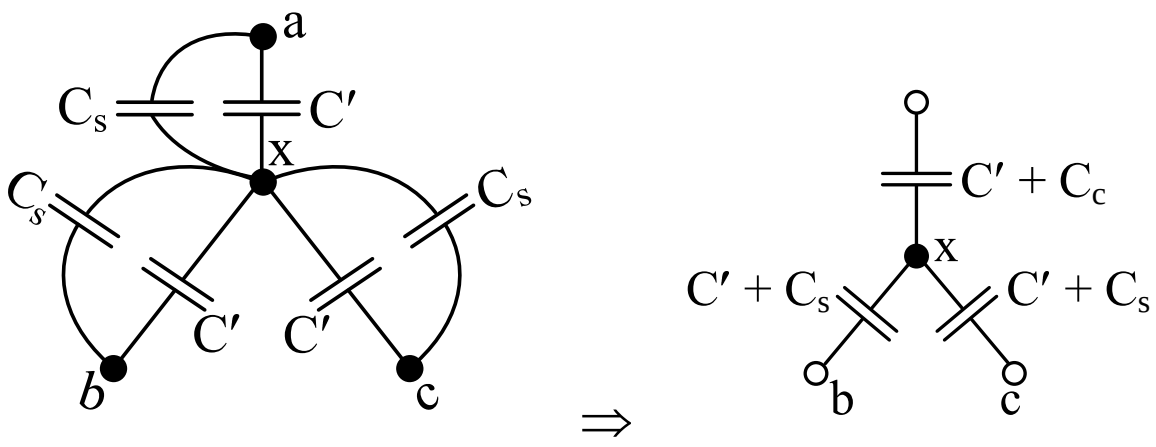
C_c are in delta $\rightarrow$ can be converted to Y



<u>Note</u> : $Z_Y = \frac{1}{3} Z_\Delta \Rightarrow \frac{1}{\omega C'} = \frac{1}{3}\left[\frac{1}{\omega C_C}\right]$

$\Rightarrow C' = 3C_C$

Now cores are at supply potential whereas sheath is at ground potential. Assuming star point (x) to be at ground potential,



⇒ Capacitance between line & neutral = C′ + C_s = 3 C_c + C_s.

- C_c & C_s can be found by simple experiments.

- Cable equivalent circuits are the same as used for T. lines. Note that due to high capacitance of cables, the charging current (especially at high voltages) is an important factor in deciding the permissible length to be used.