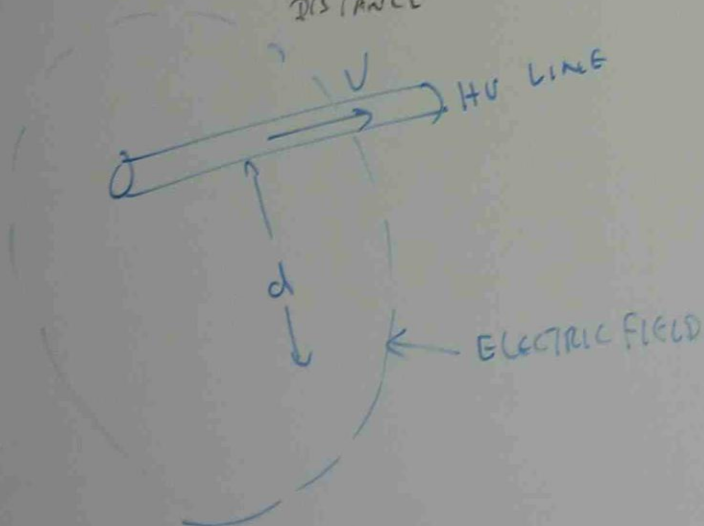
G47

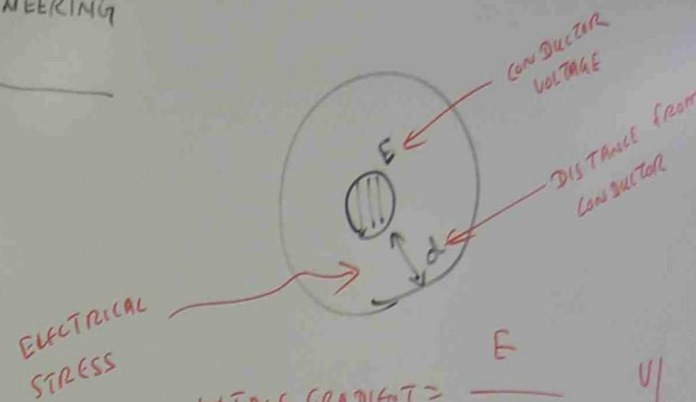
RCE

APPLICATION OF GRADIENT IN POWER ENGINEERING

$$\text{FORCE GRADIENT} = \frac{\text{TOTAL FORCE}}{\text{UNIT AREA}}$$

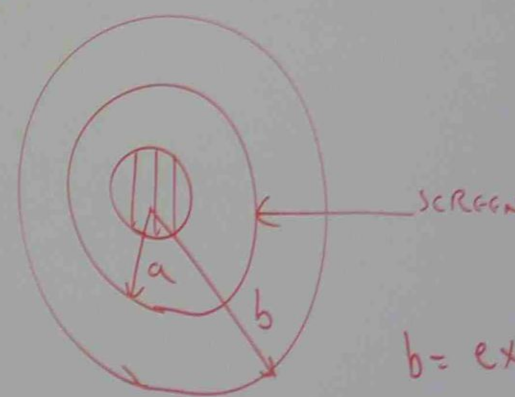
$$\text{VOLTAGE GRADIENT} = \frac{\text{VOLTAGE}}{\text{DISTANCE}}$$





$$\text{VOLTAGE GRADIENT} = \frac{E}{d} \quad V/cm$$

IT NEEDS TO RELIEVE ELECTRICAL STRESSES

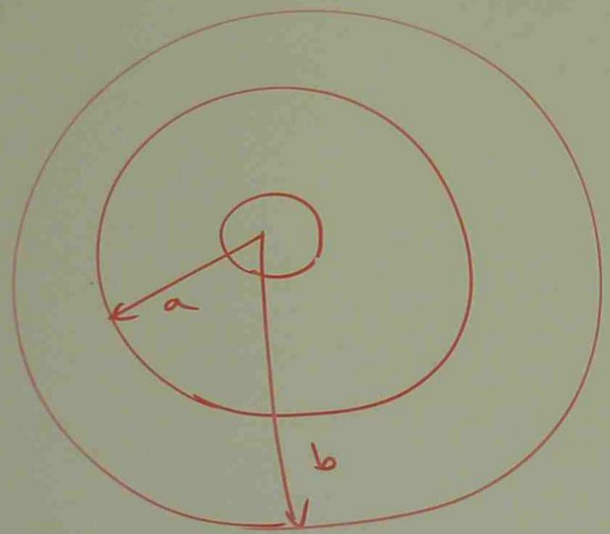


$b = e \times a$

$e = 2.718$

THE MOST ECONOMICAL CABLE

EX A SINGLE CORE CONCENTRIC CABLE IS TO BE MANUFACTURED FOR 200KV, 60HZ LINE. THE PAPER USED HAS MAXIMUM PERMISSIBLE SAFE STRESS OF 10^7 V/m (rms) AND A DIELECTRIC CONSTANT OF 4.5. CALCULATE THE DIMENSION FOR THE MOST ECONOMICAL CABLE AND THE CHARGING CURRENT PER Km.



$b = e \times a$ (MOST ECONOMICAL CABLE)

$e = 2.718$

$$\text{GRADIENT} = \frac{E}{\text{DISTANCE}}$$

$$10^7 = \frac{200 \times 10^3}{a}$$

$$a = \frac{200 \times 10^3}{10^7} = 0.02 \text{ m}$$

$$b = e \times a = 2.718 \times 0.02 = 0.0544 \text{m}$$

D

AL

APPLICATION OF NATURAL LOG FUNCTION IN POWER ENGINEERING

$$\log = \log_{10}$$

NATURAL LOG $\rightarrow \ln = \log_{2.718}$

$$\boxed{\text{CAPACITANCE OF UG CABLE} = \frac{2\pi\varepsilon}{\ln\frac{b}{a}}} \ F/km$$

ε = DIELECTRIC CONSTANT = $\varepsilon_r \times \varepsilon_0$

ε_r: RELATIVE DIELECTRIC CONSTANT OF MATERIAL

ε_0: 8.85×10^{-12}

$$C = \frac{2 \times 3.1416 \times 4.5 \times 8.85 \times 10^{-12}}{\ln\frac{0.0544}{0.02}}$$

$$= 2.5 \times 10^{-10} \ F/km$$

$$X_c = \frac{1}{2\pi fc}$$

$$= \frac{1}{2 \times 3.1416 \times 60 \times 2.5 \times 10^{-10}}$$

$$= \frac{10^{10}}{2 \times 3.1416 \times 2.5 \times 60}$$

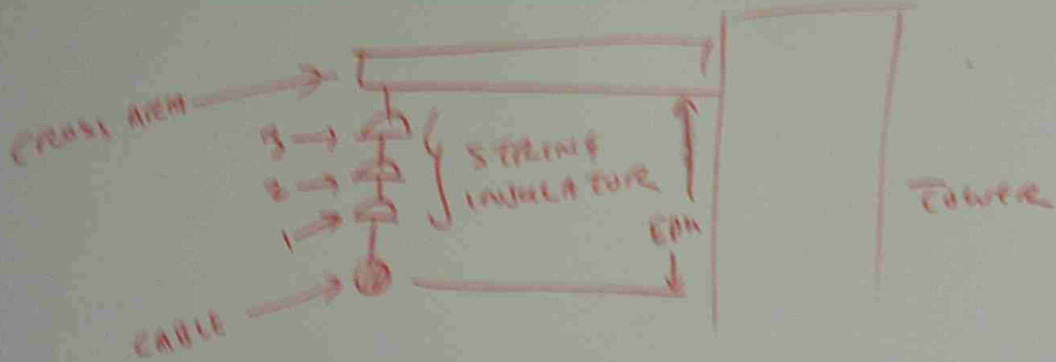
$$= 10615710 \ \Omega/km$$

CHARGING CURRENT $(I_c) = \dfrac{V}{X_c}$

$$= \frac{200 \times 10^3}{10615710}$$

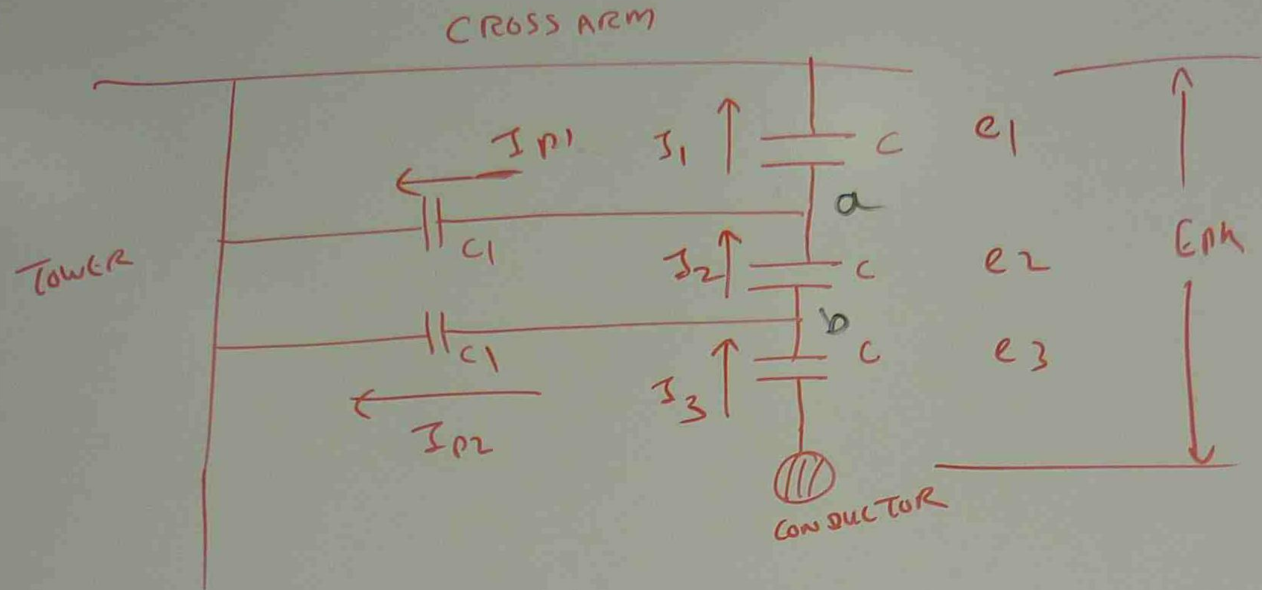
$$= 0.0188 \text{ Amp}/\text{km}$$

DERIVATION OF FORMULA TO COMPARE THE REQUIRED QUANTITIES IN POWER ENGINEERING



E_{PH} = PHASE VOLTAGE

Ex BRIEFLY DESCRIBE HOW THE CAPACITANCE OCCURS FOR 3 STRING INSULATORS. DERIVE THE EQUATION FOR POTENTIAL GRADING.



$e_1 + e_2 + e_3 =$ PHASE VOLTAGE

$K = \frac{C_1}{C}$ = RATIO BETWEEN AIR CAPACITANCE & INSULATOR CAPACITANCE

AT POINT (a)

$$I_2 = I_1 + I_{p1}$$

$\therefore C_1 = KC$

$$Ce_2 = Ce_1 + C_1 e_1$$

$$Ce_2 = Ce_1 + KCe_1$$

$$e_2 = e_1 + Ke_1$$

$$e_2 = (1+K)e_1 \quad \text{—— (1)}$$

AT POINT (b)

$$I_3 = I_2 + I_{p2}$$

$$ce_3 = ce_2 + c_1(e_1 + e_2)$$

$$ce_3 = ce_2 + kc(e_1 + e_2)$$

$$e_3 = e_2 + k(e_1 + e_2)$$

$$e_3 = (1+k)e_1 + k(e_1 + (1+k)e_1)$$

$$e_3 = [1+k + k(1 + (1+k)]e_1$$

$$e_3 = [1+k+k+k+k^2]e_1$$

$$e_3 = [1+3k+k^2]e_1 \quad \text{— (2)}$$

$$E_{ph} = e_1 + e_2 + e_3$$

$$E_{ph} = e_1 + (1+k)e_1 + (1+3k+k^2)e_1$$

$$E_{ph} = e_1[1 + (1+k) + 1 + 3k + k^2]$$

$$E_{pn} = e_1 \left[1 + 1+k + 1+3k+k^2 \right]$$

$$E_{pn} = e_1 \left[3 + 4k + k^2 \right]$$

$$e_1 = \frac{E_{pn}}{3+4k+k^2}$$

$$e_2 = (1+k)\, e_1$$

$$= (1+k) \times \frac{E_{pn}}{(3+4k+k^2)}$$

$$= \frac{E_{pn}\,(1+k)}{3+4k+k^2}$$

$$e_3 = (1+3k+k^2)\, e_1$$

$$= (1+3k+k^2) \times \frac{E_{pn}(1+k)}{(3+4k+k^2)}$$

$$= \frac{E_{pn}(1+k)(1+3k+k^2)}{(3+4k+k^2)}$$