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Question (1)

Given data:

Spacing of Conductors, $d = 2m = 2 \times 100 = 200cm$

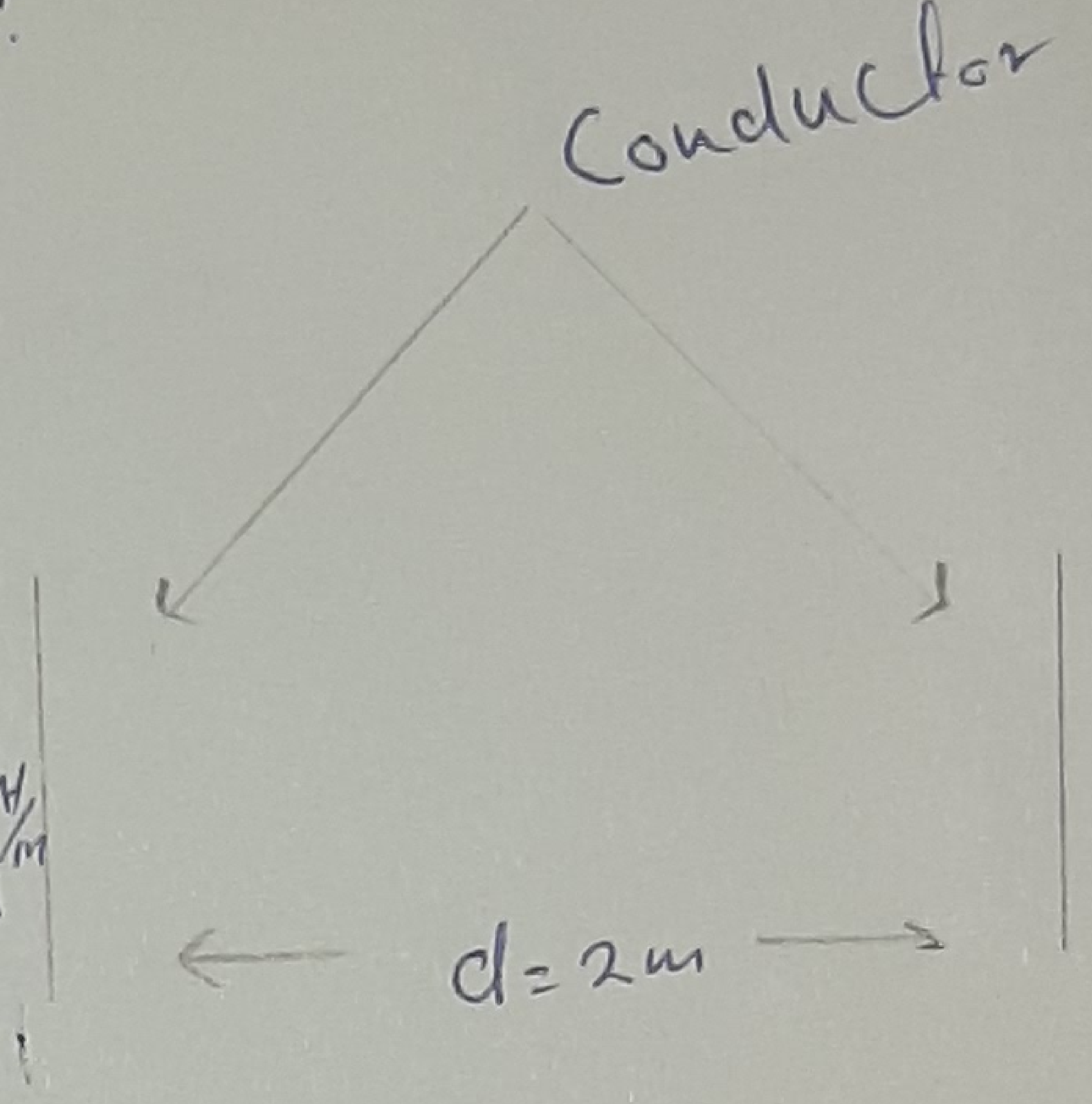
Diameter of each Conductor is $= 1.2cm$

Required data:

Loop Inductance per km of the line = ?

Solution:

We know that



Loop Inductance $= 10^{-7}[1 + 4 \log_e \frac{d}{r}]$ H/m

Loop Inductance $= 10^{-7}[1 + 4 \log_e d/r]$ H/m —

first we have to find Radius of Condu

So we know that

$$r = \frac{\text{Diameter of each Conduct}}{2}$$

$$= \frac{1.2cm}{2}$$

$$\boxed{r = 0.6 \text{ cm}}$$

Now put value in equation (

Loop Inductance $= 10^{-7}\left[1+4\log_e \frac{d}{r}\right]$ H

$= 10^{-7}\left[1+4\log_e \frac{200\,cm}{0.6\,cm}\right]$ H

$= 24.23 \times 10^{-7}$ H

Now

Loop Inductance per km of the line is

$= 24.23 \times 10^{-7} \times 1000$ mH

$= 24.23 \times 10^{-4}$ mH

$= 2.423$ mH

ANSWER:

2.423 mH

Question (2)

Given data:

Spacing of Conductors; $d = 3m = 3 \times 100 = 300c$

or

$d = 300cm$

Radiu of Conductors; $r = 1cm$

Required data:

Loop inductance per km length of the line if the material of the Conductor is

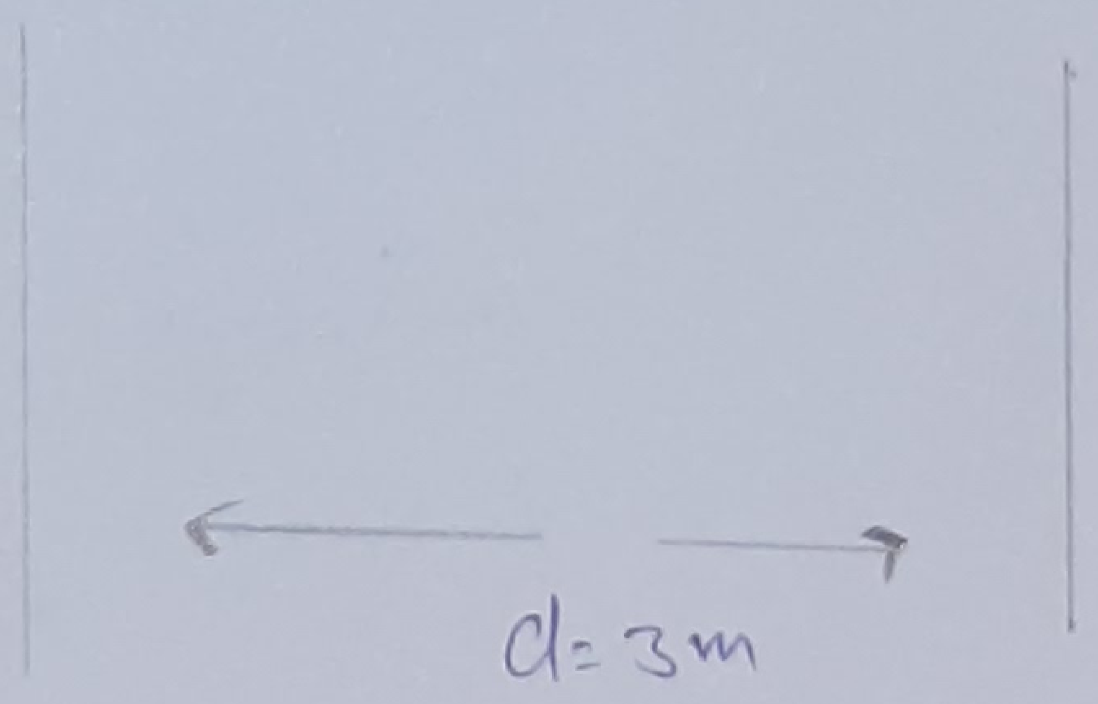
(i) Copper

(ii) Steel with relative permeability of 100

Solution:

We know that

Loop Inductance is



$$= 10^{-7}\left(\mu_r + 4\log_e d/r\right) \text{ H/m} \quad -(1)$$

i) Copper = ?

We know that with Copper Conductors relative permeability is $\mu_r = 1$

So

Loop Inductance is $= 10^{-7}(\mu_r + 4\log_e d/r)$ H/m —①

put value in equation

$= 10^{-7}\left(1 + 4\log_e \frac{300\,cm}{1\,cm}\right)$ H

$= 23.8 \times 10^{-7}$ H

Now

Loop Inductance/km $= 23.8 \times 10^{-7} \times 1000$ H

$= 2.38 \times 10^{-3}$ H

Loop Inductan/km $= 2.38$ mH

(ii) Steel with relative permeability $\mu_r = 100$

∴ loop Inductance/m $= 10^{-7}(\mu_r + 4\log_e d/r)$ H/m —①

put value in equation

$= 10^{-7}(100 + 4\log_e 300/1)$

$= 122.8 \times 10^{-7}$ H

Now

Loop Inductance/km $= 122.8 \times 10^{-7} \times 1000$ H

$= 12.28 \times 10^{-3}$ H

Loop Inductan/km $= 12.28$ mH

Question (3)

Answer:-

Capacitance and inductance are the main parameters of the lines having a length 240 km or above.

-> On such transmission line, the Capacitance is not Concentrated at some definite point.

-> It is distributed uniformly along the whole length of the line.

Now when the voltage is applied at the Sending end the current drawn by the Capacitance of the line is more than current associated with the load.

-> Thus at no load or light load, the voltage at the receiving end is quite large as compared to the constant voltage at the sending end.

Question 4

Given data:

A 3-ϕ load ; 2000 KVA

Power factor = 0.8

Transmission line ; 33KV

Length = 20 km

Step down transformer ; 33/6.6 KV

Resistance of each conductor = 0.4 Ω/km

Reactance of each conductor = 0.5 Ω/km

primary resistance of transformer = 7.5 Ω

primary reactance of transformer = 13.2 Ω

Secondary resistance of transformer = 0.35 Ω

Secondary reactance of T/F = 0.65 Ω

Required data:.

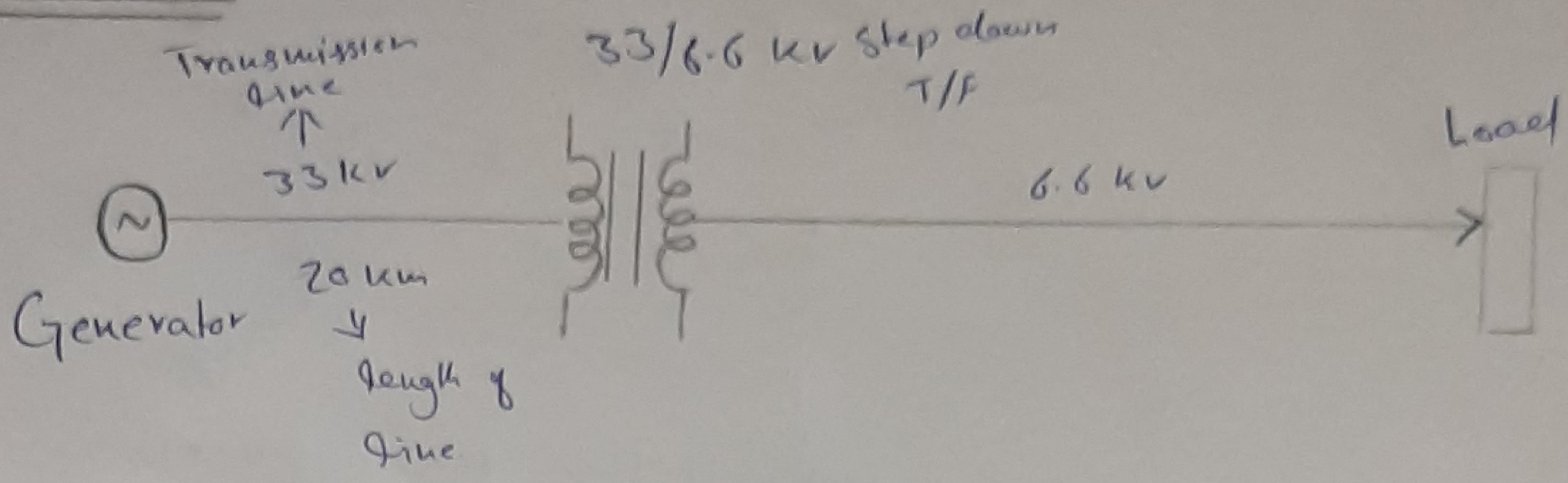
Sending end line voltage = ?

Sending end power factor = $\cos\phi$ = ?

Transmission Effeciency = ?

Solution:

(8)



Single line transmission system is shown in the above figure; Here the voltage drop will be due to impedance of transmission line and also due to the the T/F.

So Resistance of each conductor $= 20 \times 0.4 = 8\Omega$

Reactance of each conductor $= 20 \times 0.5 = 10\Omega$

Let us T/F the impedance of T/F secondary to high tension side: 33kV

Equivalent resistance of T/F reffered to 33kV side $=$ primary resistance $+ 0.35(33/6.6)^2$

$= 7.5 + 8.75$

$= 16.25\,\Omega$

Equivalent reactance of T/F reffere to 33kV side $=$ primary reactance $+ 0.65(33/6.6)^2$

$= 13.2 + 16.25$

$= 29.45\,\Omega$

Total reactance of line & T/F is

$X_L = 10 + 29.45$

$\boxed{X_L = 39.45\Omega}$

Receiving end voltage/phase =

$V_R = 33000/\sqrt{3}$

$\boxed{V_R = 19052V}$

Line Current ; $I = \frac{2000 \times 10^3}{\sqrt{3} \times 33000}$

$\boxed{I = 35A}$

Now

Sending End voltage/phase is

$V_S = V_R + IR \cos\phi_R + I X_L \sin\phi_R$ — ①

put value in equation.

$= 19052 * (35 \times 24.25 \times 0.8) + (35 \times 39.45 \times 0.6)$

$= 19052 + 679 + 828$

$= 20559V$

$\boxed{V_S = 20.559 kV}$

Now Sending end power factor $\cos\phi_S = ?$

$\cos\phi_S = \frac{V_R \cos\phi_R + IR}{V_S}$ — ②

put value in equation ②

$$\cos\phi_s = \frac{19052 \times 0.8 + 35 \times 24.25}{20559}$$

$$= \frac{15241.6 + 848.75}{20559}$$

$$= \frac{16090.35}{20559}$$

$$\boxed{\cos\phi_s = 0.782 \text{ lag}}$$

Sending end line voltage $= \sqrt{3} \times 20.559\,kV$

$$\boxed{= 35.6\,kV}$$

Line losses $= \frac{3I^2R}{1000}\,kW$ — ①

$$= \frac{3(35)^2 \times (24.25)}{1000}$$

$$= \frac{89118.75}{1000}$$

$$\boxed{\text{Line losses} = 89.11\,kW}$$

output power $= 2000\,KVA \times 0.8$

$$\boxed{\text{output power} = 1600\,kW}$$

→ Transmission efficiency $= \frac{\text{output power}}{\text{output power} + \text{line losses}} \times 100$

$$= \frac{1600}{1600 + 89.11} \times 100$$

$$\boxed{\text{Transmission Effeciency} = 94.72\,\%}$$

ANSwers:

(i) Sending end line voltage = 35.6 kV

(ii) Sending end power factor $\cos\phi_s$ = 0.782 lag

(iii) Transmission effeicency = 94.72%

Question (5)

Given data:

Diameter of conductor; $= 1.956$ cm

Radius of conductor; $r = \frac{1.956}{2} = 0.978$ cm

Air density factor; $\delta = 1$

Irregularity factor; $m_o = 1$

Potential gradient; $E_o = 30$ kV/cm

Required data:

Spacing of conductor; d ?

Solution:

$E_o = 30/\sqrt{3} = 21.1$ (r.m.s)

Now

Critical disruptive voltage $= 21.1\, m_o \delta r \ln d/r$. (1)

Now disruptive voltage / phase $= \frac{210}{\sqrt{3}}$

$V_o = 121.25$ kV

put value in equ (1)

$V_o = 21.1\, m_o \delta r \ln d/r$

121.25 kV $= 21.1 \times 1 \times 1 \times 0.978 \ln d/r$

$\Rightarrow 121.25 = 20.6358 \ln d/r$ (13)

Divide Both side by 20.6358

we get

$$\ln d/r = \frac{121.25}{20.6358}$$

$$\ln d/r = 5.87$$

Now

Spacing between Conduct $d = 34/cm$

Answer:

$$\boxed{d = 34/cm}$$