Name : Shafiq ur Rehman

ID : 14854

Q1 (A):- In a 66kV overhead line there are three units in the string of Insulators if the Capacitance b/w each Insulator pin and earth is 22% of Self - Capacitance of each Insulator. Find

I) The distribution of voltage over 3 Insulators and

II) String efficiency.

Answer:- The below figure shows the equivalent Circuit of String insulators

Let V_1, V_2 and V_3 be bottom unit respectively. if C is the Self Capacitance of each unit then KC will be the Shunt Capacitance.

$$K = \frac{\text{Shunt Capacitance}}{\text{Self Capacitance}} = 0.11$$

Voltage across String, $V = 66/\sqrt{3} = 38.10\text{kV}$

At Junction A

$$I_2 = I_1 + i_1$$

or $V_2 \omega C = V_1 \omega C + V_1 k \omega C$

or $V_2 = V_1 (1+k) = V_1 (1+0.11)$

or $V_2 = 1.11 V_1$

Name : Shafiq ur Rehman.

ID : 14854

At Junction B :-

$$I_3 = I_2 + i_2$$

or $V_1 \omega C = V_2 \omega C + (V_1 + V_2) k \omega C$

or $V_3 = V_2 + (V_1 + V_2) k$

$= 1.11V_1 + (V_1 + 1.11V_1)\, 0.11$

$V_3 = 1.342V_1$

(i) Voltage across the whole String is

$V = V_1 + V_2 + V_3 = V_1 + 1.11V_1 + 1.342V_1 = 3.452V_1$

or $38.10 = 3.452V_1$

∴ Voltage across top unit, $V_1 = 38.10/3.452 = 11.03\,kV$

Voltage across middle unit, $V_2 = 1.11V_1 = 1.11 \times 11.03 = 12.24\,kV$

Voltage across bottom unit, $V_3 = 1.342V_1 = 1.342 \times 11.03 = 14.80\,kV$

(ii) Spring efficiency = $\dfrac{\text{Voltage across String}}{\text{No of Insulators} \times V_3} \times 100$

$= \dfrac{38.10}{3 \times 14.80} \times 100$

$= 85.81\,\%$

Name : Shafiu ur Rehman
ID : 14859

Page No : 3

Question 1 (B) :- A 3-Phase line has Conductors 4cm in diameter spaced equilaterally 2m apart if the dielectric strength of air is 30kv (max) per cm.

Find the disrupitive critical voltage for the line. Take air density factor $\delta = 1.5$ and irregularity factor $m_0 = 0.6$.

Solution :-

Conductor Radius $r = 4/2 = 2$ cm

Conductor Spacing $d = 2m = 200$ cm

Dielectric Strength of air $g_0 = 60$ kv/cm (max)

$= 42.4$ kv (r.m.s) per s cm

Disruptive Critical voltage (dr) kv phase (r.ms value)

$= 0.6 \times 42.4 \times 1.5 \times 2 \times \log_e \frac{200}{2}$

$= 353.46$ kv/phase

$\therefore$ line Voltage (r.m.s)

$= \sqrt{3} \times 353.46 = 612.21$ kV

Name : Shafiq ur Rehman

ID : 14859

Page : 4

Question 3 (A) A transmission line has a span of 400 meter between level supports The Conductor has a cross - sectional area of 2.34 cm2, weighs 70 kg/km and has a breaking stress of 42 kg/cm2

Calculate the sag for a safety factor of 6, allowing a wind pressure of 522 kg per square meter of projected area. what is the vertical sag?

Solutions-

Span length $l = 400\,m$ wt. of Conductor /m length

$w = 70/1000 = 0.07\,kg$

working tension $T = 42 \times 2.34/6 = 16.38\,kg$

Diameter of Conductor $= d = \sqrt{\frac{4 \times area}{\pi}}$

$= \sqrt{\frac{4 \times 2.34}{\pi}} = 1.726\,cm$

wind force /m length, $w_w =$

Pressure x Projected area in m2

$= (522)\,(1.72 \times 10^{-2} \times 1)$

$= 8.97\,kg$

Total weight of Conductor per meter length is $w_t = \sqrt{w^2 + w_w^2}$

Name Shafiq ur Rehman

ID 14859

Page No # 5

$$= \sqrt{(0.07)^2 + (8.97)^2} = 8.9702 \text{ kg}$$

$\because$ Slant Sag $= S = \dfrac{wt\, I^2}{8t}$

$$= \frac{8.970 \times (400)^2}{8 \times 16.38}$$

$S = 1095.23$ m

The Slant Sag makes an angle ϕ with verticle where value ϕ is given by

$\phi = \tan^{-1}(Ww/w)$

$= \tan^{-1}(8.97/0.07)$

$= \tan^{-1}(8.97 \alpha 0.07)$

$= 89.55°$

verticle Sag $= S \cos\phi$

$= 1095.23 \times \cos 89.55$

verticle Sag $= 8.601$ m

Name : Shafiq ur Rehman

ID : 14859

Page : 6

Question No 3(B) The towers of height 60m and 120m respectively support a transmission line conductor at water crossing. The horizontal distance between the towers is 800 m. If the tension in the conductor is 400kg.
Find the minimum clearance of the conductor and water and clearance mid-way between the supports. Weight of conductor is 3.5 kg/m. Bases of the towers can be considered to be at water level.

Solution:- Here $l = 800m$

$w = 3.5kg$: $T = 400kg$

Difference in levels between supports $h = 60 - 120$
$= 60m$. Let the lower point O of the conductor be at a distance x from the support at lower level (i.e support A) & at a distance x_2 from the support at higher lower (i.e support

$$x_1 + x_2 = 800m$$

Now: Sag $S_1 = \frac{wx_1^2}{2T}$ & Sag $S_2 = \frac{wx_2^2}{2T}$

$$\therefore h = S_2 - S_1 \quad \frac{wx_2^2}{2T} - \frac{wx_1^2}{2T}$$

or $$60 = \frac{w}{2T}(x_2 + x_1)(x_2 - x_1)$$

$$\therefore x_2 - x_1 = \frac{60 \times 2 \times 400}{3.5 \times 800} = 17.14 \text{ m}$$

Shafiq ur Rehman

ID : 14859

Page No 7

Solving (I), (II) we get.

$X_1 = 391.43, \quad X_2 = 408.57$

Now $S_1 = \frac{w x_1^2}{2T} = \frac{3.5 \times (391.43)^2}{2 \times 400}$

Clearance of the lowest point C from the water fa

$= 60 - 6.702 = 53.298\,m$

Let the mid point P be at a distance x from the lowest point clearly.

$X = 400 - X_1 = 400 - 391.43 = 8.57m$

Sag & mid Point p

$S_{mid} = \frac{w x^2}{2T} = \frac{3.5 \times (8.57)^2}{2 \times 400} = \frac{257.05}{800}$

$= 0.3213\,m$

Clearance of mid Point P from water level

$= 53.298 + 0.3213$

$= 53.611m$

Name Shafiq ur Rehman

ID 14859

Page No 8

Question 2: An overhead transmission line conductor having a parabolic configuration weight 3.789 kg per meter of length. The area of X-section of the conductor is 6.2 cm² and the ultimate strength is 950.665 kg/cm². The supports are 300m apart having 2.5m difference of levels. Calculate the sag from the taller of the two supports which must be allowed so that the factor of safety shall be 2. Assume that ice load is 2 kg per meter run and there is no wind pressure.

Answers: Here $l = 300m$

$w_i = 2kg$

$h = 2.5m$

$w = 3.789 kg$; $T = 950.665 \times 6.2/2$

$= 2,9470.6 kg$

Total weight of 1m length of conductor is

$W_1 = W + w_i = 3.789 + 2 = 5.789 kg$

Let the lowest point O of the conductor be at a distance x_1 from the support at lower level

Name : Shafiq ur Rehman

ID ~~Mss~~ 14859

Page No 9

$$x_1 + x_2 = 300\,m$$

Now

$$h = S_2 - S_1 = \frac{w_t x_2^2}{2T} - \frac{w_t}{2T}$$

or $$25 = \frac{w_t}{2T}(x_2 + x_1)(x_2 - x_1)$$

$\therefore$ $$x_2 - x_1 = \frac{2 \times 25 \times 2947.08}{5.789 \times 300} = 84.84\,m$$

Showing exps (i) & (ii) we have

$x_1 = 107.58\,m$ $x_2 = 192.42\,m$

Sag from the taller of the two tower is

$$Sag = \frac{w_t x_2^2}{2T}$$

$$= \frac{5.789 \times (192.42)^2}{2 \times 950.885}$$

$$= \boxed{112.73\,m}$$

We Department of Electrical Engineering

Assignment

Date: 14/04/2020

Course Details

Course Title:	Electric Power Transmission	**Module:**	4rth
Instructor:	Engr Ami amaan	**Total Marks:**	30

Student Details

Name:	shafeq khan	**Student ID:**	14859

Q1	(a)	In a 66 kV overhead line, there are three units in the string of insulators. If the capacitance between each insulator pin and earth is 22% of self-capacitance of each insulator, Find i) The distribution of voltage over 3 insulators and ii) String efficiency.	Marks 05 CLO 1
	(b)	A 3-phase line has conductors 4 cm in diameter spaced equilaterally 2 m apart. If the dielectric strength of air is 60 kV (max) per cm. Find the disruptive critical voltage for the line. Take air density factor $\delta = 1.5$ and irregularity factor $m_o = 0{\cdot}6$.	Marks 05 CLO 1
Q2	(a)	An overhead transmission line conductor having a parabolic configuration weighs 3.789 kg per meter of length. The area of X-section of the conductor is $6{\cdot}2\ cm^2$ and the ultimate strength is $950.665\ kg/cm^2$. The supports are 300 m apart having 25 m difference of levels. Calculate the sag from the taller of the two supports which must be allowed so that the factor of safety shall be 2. Assume that ice load is 2 kg per meter run and there is no wind pressure.	Marks 10 CLO 1
Q3	(a)	A transmission line has a span of 400 meters between level supports. The conductor has a cross-sectional area of 2.34 cm2, weighs 70 kg/km and has a breaking stress of $42\ kg/cm^2$. Calculate the sag for a safety factor of 6, allowing a wind pressure of 522 kg per square meter of projected area. What is the vertical sag?	Marks 05 CLO 2
	(b)	The towers of height 60 m and 120 m respectively support a transmission line conductor at water crossing. The horizontal distance between the towers is 800 m. If the tension in the conductor is 400 kg, Find the minimum clearance of the conductor and water and clearance mid-way between the supports. Weight of conductor is 3.5 kg/m. Bases of the towers can be considered to be at water level.	Marks 05 CLO 2