Department of Electrical Engineering
Assignment
Date: 14/04/2020

Course Details

Course Title:	Electric Power Transmission	**Module:**	4rth
Instructor:	Engr. AMIR AMAAN	**Total Marks:**	30

Student Details

Name:	AZHAD NIAZ	**Student ID:**	15493

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 δ = 1.5and irregularity factor mo = 0·6.	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 6·2 $cm^2$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

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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.\

SOLUTION:

the bellow figure shows the equivalent circuit of string insulators

Let V1, V2 and V3 be the voltage across top, middle and bottom unit respectively. if C is the self capacitance of each unit then KC will b the shunt capacitance

$$K= \frac{SHUNT\ CAPACITANCE}{SELF\ CAPACITANCE}$$

= 0.11

Voltage across string,

V=66/ $\sqrt{3}$ =38.10kv

At junction A

$$I_2 = I_1 + i_1$$

Or $v_2\ \omega C = v_1\ \omega C + v_1 K \omega C$

Or $v_2 = v_1(1+K) = v_1(1$

0r $v_2 = 1.11\, v_1$

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At Junction B

$I_3 = I_2 + i_2$

Or $v_1 \omega$C=V2 ω c+ (v_1+V2) K ω c

Or $v_3 = v_2$ + (v_1+V2) K

=1.11 v_1+ (v_1+1.11 v_1)0.11

v_3=1.342 v_1

(i) Voltage across the whole string is

V= $v_1 + v_2 + v_3 = v_1$+1.11 v_1+1.342 v_1=3.452 v_1

Or 38.10=3.452 v_1

Voltage across top unit, v_1=38.10/3.452=11.03KV

Voltage across middle unit, v_2 =1.11 v_1=1.11 $\times$ 11.03=12.24KV

Voltage across bottom unit, v_3 =1.342 v_1=1.342 $\times$ 11.03=14.80KV

$$\frac{voltage\ across\ string}{no.of\ insulators \times v3} \times 100$$

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

= 85.81%

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Q1 :(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 δ = 1.5and irregularity factor mo = 0·6

SOLUTION:

Conductor radius r = 4/2 = 2cm

Conductor spacing d = 2m = 200cm

Dielectric strength of air g_n = 60kv/cm (max) = 42.4kv (rms) per cm

Disruptive critical voltage Vc = $m_o g_o$ δ r log (d/r) kv/phase (rms value)

= 0.6×42.4×1.5×2×log×200/2

= 353.46 kv/phase

. Line voltage (rms)

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

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 6·2 $cm^2$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

SOLUTION:

Given data; Here I = 300m

WI = 2kg

H = 25m W = 3.789kg

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Q2 (A):

T = 950.665× 6.2/2 = 2,947.06kg

Total weights of 1m length of conductor is Wt = W+w_i = 3.789 +2

= 5.789kg

Let the lowest point O of the conductor be at a distance X1 from the support at lower level (i-e A)

And at a distance X2 from the support at higher level (i-e B)

X1 + X2 = 300m ………. (i)

So,

$$h = S2-S1 = \frac{Wt\, x_2^2}{2t} - \frac{Wt\, x_1^2}{2t}$$

or

$$25 = \frac{wt}{2t}\left(x_{2+X_1}\right)\left(x_{2-X_1}\right)$$

$$x_2\text{-}x_1 = \frac{2\times25\times2947.06}{5.789\times300}$$

= 84.84m …… (i)

Eq (i) & (ii) we get x_1 = 107.58m & x_2 = 192.42m

Sag from the taller the two towers is

$$S_2 = = \frac{Wt\, x_2^2}{2t} = \frac{5.789\left((192.420)^2\right)}{2\times950.665}$$

= 112.73m

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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?

SOLUTION:

Span length l=400m

Wt.0f conductor/ m length w=70/1000

Working tension T =42×2.34/6 =16.38kg

Diameter of conductor = d = $\sqrt{4\times area/\pi}$

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

=1.726cm

Wind force/m length, Wm=pressure projected area in m²

= (S22) (1.72× $10^{-2}\times 1$)

Total weight of conductor per meter length is

Wt= $\sqrt{w^2+Ww^2}$

$\sqrt{(0.07)^2+(8.97)^2}$

=8.9702kg

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Q3(A):

$\therefore$ Slant sag

$$\frac{WtI^2}{8t}$$

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

$$S = 1095.23cm$$

The slant sag makes an angle θ is given by

$$\theta = \tan^{-1}(Ww/W)$$

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

$$= 89.55$$

Vertical sag = s cos θ

= 1095.23×cos 89.55

Vertical sag =8.601 m

Q3:(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.

SOLUTION:

Given data:

Here I= 800m

w= 3.5kg

T = 400kg

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Q3(B):

Difference m level between supports h=60-120=60m

Let the tower point of the conductor be at a distance X1 from the support at tower level A and at a distance X2 from the support at high level support at high

So X_1+X_2 = 800m ……(i)

Now

Sag S1 = $S1 = \frac{W\,x_2^2}{2t}$ and sag $S2 = \frac{W\,x_1^2}{2t}$

$$h = S2 - S1 = \frac{W\,x_2^2}{2t} - \frac{W\,x_1^2}{2t}$$

$$60 = \frac{W}{2t}(X_2+X_1)(X_2-X_1)$$

$$x_2 - x_1 = \frac{60\times2\times400}{3.5\times800}$$

= 17.14m ….(ii)

Comparing Eq (i) & (ii) x_1= 391.43 and x_2= 408.57

$$S_1 = \frac{W\,x_1^2}{2t}$$

$$= \frac{3.5\times(391.43)^2}{2\times400}$$

= 6.702m

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Q3 (B):

The clearance of lowest point O from the water

= 60-6.702 = 53.298m

So now the midpoint P be at distance x from lowest point O

X= 400-X1 = 400-391.43

= 8.57m

Sag & midpoint P

$$S_{mid} = \frac{W\,x^2}{2t} = \frac{3.5\times(8.57)^2}{2\times400}$$

$= \frac{257.05}{800}$ = 0.3213m

Clearance of midpoint P from water level

= 53.298+0.3213

= 53.611m