Department of Electrical Engineering
Assignment
Date: 24/06/2020

Course Details

Course Title: Electric Power Transmission **Module:** 4rth
Instructor: Engr. Aamir Aman **Total Marks:** 50

Student Details

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Q1	A single phase line has two parallel conductors 2 meters apart. The diameter of each conductor is 1·2 cm. Calculate the loop inductance per km of the line.	Marks 10 CLO 1
Q2	A single phase transmission line has two parallel conductors 3 m apart, the radius of each conductor being 1 cm. Calculate the loop inductance per km length of the line if the material of the conductor is (i) Copper (ii) Steel with relative permeability of 100.	Marks 10 CLO 1
Q3	A long transmission lines more than 240kms are consisting of high amount of capacitance and inductance distributed across the entire length of the line. Ferranti effect occurs when current drawn by the distributed capacitance of the line itself is greater than the current associated with the load at the receiving end of the line (during light or no load). Why Ferranti effect occurs in long transmission line? Back your answer with valid data, facts and figures.	Marks 10 CLO 1
Q4	A 3-phase load of 2000 kVA, 0·8 p.f. is supplied at 6·6 kV, 50 Hz by means of a 33 kV transmission line 20 km long and 33/6·6 kV step-down transformer. The resistance and reactance of each conductor are 0·4 Ω and 0·5 Ω per km respectively. The resistance and reactance of transformer primary are 7.5 Ω and 13.2 Ω, while those of secondary are 0.35 Ω and 0.65 Ω respectively. Find the voltage necessary at the sending end of transmission line when 6.6 kV is maintained at the receiving end. Determine also the sending end power factor and transmission efficiency.	Marks 10 CLO 2
Q5	A 132 kV line with 1.956 cm dia. conductors is built so that corona	Marks 10

	takes place if the line voltage exceeds 210 kV (r.m.s.). If the value of potential gradient at which ionization occurs can be taken as 30 kV per cm, find the spacing between the conductors.	CLO 2

Answer Sheet

Q1:

A single phase line has two parallel conductors 2 meters apart. The diameter of each conductor is 1•2 cm. Calculate the loop inductance per km of the line.

Ans:

Solution

Spacing of conductors, d = 2 m = 200 cm

Radius of conductor, r = $\frac{1.2}{2}$ = 0·6 cm

Loop inductance per meter length of the line= 10−7 ($\frac{1+4 \text{ logged}}{r}$) H

= 10−7 ($\frac{1+4 \text{ loge } 200}{0.6}$) H = 24·23 ×10−7 H

Loop inductance per km of the line = 24·23 ×10−7 ×1000 H

= 24·23 ×10−4 H = 2·423 mH **Ans.**

Q2:

A single phase transmission line has two parallel conductors 3 m apart, the radius of each conductor being 1 cm. Calculate the loop inductance per km length of the line if the material of the conductor is

(i) Copper

(ii) Steel with relative permeability of 100.

Ans:

Solution

Spacing of conductors, d = 300 cm

Radius of conductor, r = 1 cm

Loop inductance = 10−7 $\left(\frac{\mu r + 4 \log_e d}{r}\right)$ H/m

∴ Loop inductance/m = 10^{-7} $\left(\frac{1 + 4 \log_e d}{r}\right)$ H = 10^{-7} $\left(\frac{1 + 4 \log_e 300}{1}\right)$ H = 23.8× 10^{-7}

Loop inductance/km = 23·8 × 10^{-7} × 1000 = 2·38 × 10^{-3} H = 2·38 mH

(i) With steel conductors, μ r = 100

∴ Loop inductance/m = 10^{-7} $\left(\frac{100 + 4 \log_e 300}{1}\right)$ H = 122·8 × 10^{-7}H

Loop inductance/km = 122·8 × 10^{-7} × 1000

= 12·28 × 10^{-3} H

= 12·28 mH **Ans.**

Q3:

A long transmission lines more than 240kms are consisting of high amount of capacitance and inductance distributed across the entire length of the line. Ferranti effect occurs when current drawn by the distributed capacitance of the line itself is greater than the current associated with the load at the receiving end of the line (during light or no load). Why Ferranti effect occurs in long transmission line? Back your answer with valid data, facts and figures.

Ans:

A long transmission line can be considered to be composed of a considerably high amount of capacitance and inductor distributed across the entire length of the line. Ferranti Effect occurs when current drawn by the distributed capacitance of the line is greater than the current associated with the load at the receiving end of the line which occur during light or no load.

In Ferranti effect the receiving end voltage is much greater than the sending end voltage in lightly loaded conditions. Basically transmission line parameters are Capacitor and inductor. Under lightly loaded conditions the capacitor dominates in the line and raises the voltage at the receiving end so this needs to be the reduce because this may lead to the high reactive power transmission so we connect SHUNT REACTOR which will absorb these VARs.The % Rise in voltage in an EHV Transmission Line depends on the square of its length of line.

% dV is approximately = 0.55×(L/100)2

Where L=line length in km and dV = Change in Voltage

If it’s a short line no control is needed as the voltage rise will not be significant during light load or no load condition i.e. Ferranti Effect will not be dominating. For a medium length line of 250 km the rise in voltage will be about 9.4% and it is above tolerance limit of 5% for 400 kV and above.

Q4:

A 3-phase load of 2000 kVA, 0•8 p.f. is supplied at 6•6 kV, 50 Hz by means of a 33 kV transmission line 20 km long and 33/6•6 kV step-down transformer. The resistance and reactance of each conductor are 0•4 Ω and 0•5 Ω per km respectively. The resistance and reactance of transformer primary are 7.5 Ω and 13.2 Ω, while those of secondary are 0.35 Ω and 0.65 Ω respectively. Find the voltage necessary at the sending end of transmission line when 6.6 kV is maintained at the receiving end. Determine also the sending end power factor and transmission efficiency.

Ans:

Solution

Fig. 10.7 shows the single diagram of the transmission system. Here, the voltage drop will be due to the impedance of transmission line and also due to the impedance of transformer.

Resistance of each conductor = 20 x 04 = 8Ω

Reactance of each conductor = 20 x 0.5 = 10Ω

Let us transfer the impedance of transformer secondary to high tension side i.e., 33 kV side.

Equivalent resistance of transformer referred to 33 kV side

= Primary resistance + 0.35 (33/6.6)2

= 7.5 + 815 = 16.25Ω

Equivalent reactance of transformer referred to 33 kV side

= Primary reactance + 0.65 (33/6.6)2

=13-2 + 16-25 = 29-45Ω

Total resistance of line and transformer is

R = 8+16.25=24.25Q

Fig:

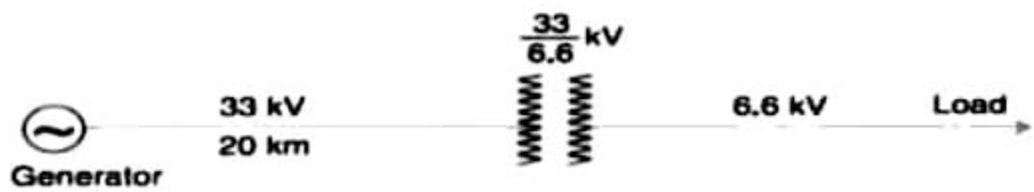

Fig. 10.7

Total reactance of line and transformer is

$$x_L = 10 + 29.45 = 39.45\Omega$$

Receiving end voltage per phase is

$$v_R = 33{,}000/\sqrt{3} = 19052 \text{ V}$$

Line current

$$I = \frac{2000 \times 10^3}{\sqrt{3} \times 33000} = 35 \text{ A}$$

Using the approximate expression for sending end voltage v_s per phase.

$$v_s = v_R + \text{IR} \cos \phi_R + \text{I}x_L \sin\phi_R$$

$$= 19052 + 35 \text{ x } 24\text{-}25 \text{ x } 0\text{-}8 + 35 \text{ x } 39\text{-}45 \text{ x } 0\text{-}6$$

$$= 19052 + 679 + 828 = 20559 \text{ V} = 20\text{-}559 \text{ kV} = 45$$

Sending end line voltage $= \sqrt{3} \times 20.559$ kV = 35.6 Kv

Sending end p.f. $\text{Cos}\phi_s = \frac{v_R \cos\phi_R + IR}{v_s} = \frac{19052 \times 0.8 + 35 \times 24.25}{1000}$ =89.12 Kw

$$= \frac{3I^2R}{1000} \text{ kW} = \frac{3 \times (35^2) \times 24.25}{1000} = 89.12 \text{ Kw}$$

$$= 2000\text{Kva} \times 0.8 = 1600\text{Kw}$$

Transmission efficiency

$$= \frac{1600}{1600 + 89.12} \times 100 = 94.75\ \%$$ **Ans.**

Q5:

A 132 kV line with 1.956 cm dia. conductors is built so that corona takes place if the line voltage exceeds 210 kV (r.m.s.). If the value of potential gradient at which ionization occurs can be taken as 30 kV per cm, find the spacing between the conductors.

Ans:

Solution

$r \frac{1.956}{2} = 0.978cm$

$E_o = \frac{30}{\sqrt{3}} = 21.2(r.m.s)$

$m_o = 1$ (smooth conductor)

δ = 1 (stander pressure and temperature

$V_o = 21.1 m_o \delta\ r\ 1n \frac{d}{r}$

Disruptive voltage/phase = $\frac{210}{\sqrt{3}}$ = 121.25Kv

$\therefore 121.25 = 21.1\times1\times1\times D.978\times1n\frac{d}{r}$

$1n\frac{d}{r} = 5.84$

= d=34/cm **Ans.**