North South University

Midterm

Power Systems

Course Code: EEE362

Section: 02

Course Instructor

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Answer to question No :3

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The value of base KVA, $S_{base} = 50KVA$.

base voltage, $V_{base} = 2400\ V$.

$$\therefore Z_{base} = \frac{V^2_{base}}{S_{base}} = \frac{2400^2}{50\times10^3} = 115.2\Omega.$$

For G_1,

$$Z_{g,pu} = \frac{Z_{actual}}{Z_{base}} \quad \text{where } Z_{actual} = \text{actual impedance.} \quad \ldots\ldots (1)$$

$$Z_{actual} = Z_{old\,g,p.u} \times Z_{base}.$$

Substitute $j0.2$ p.u for $Z_{old\,g,p.u}$

$$Z_{actual} = (j0.2)\left(\frac{2400^2}{10^4}\right) = j115.2\Omega$$

Substitute $j115.2\ \Omega$ for Z_{actual} & $115.2\ \Omega$ for Z_{base}.

$$Z_{g,pu} = \frac{j115.2}{115.2}\ p.u = j\ p.u.$$

For G_2,

$$Z_{g2\,p.u} = \frac{Z_{actual}}{Z_{base}} \quad \ldots\ldots (ii).$$

$$Z_{actual} = (j0.2)\ \frac{2400^2}{20\times10^3} = j57.6\Omega.$$

$$Z_{g_2\,p.u} = \frac{j57.6}{115.2}\ p.u. = \frac{1}{2}j\ p.u.$$

Calculating actual impedance of the transformer by the rated values from p.u value.

$$Z_{actual} = j0.1\left(\frac{2400^2}{40\times10^3}\right) = j14.4\Omega.$$

$$Z_{1\,p.u} = \frac{j14.4}{115.2}\ p.u. = 0.125j.$$

for Transformer T_2.

$$Z_{actual} = (j0.1)\left(\frac{10000^2}{80\times10^3}\right) = j125\ \Omega.$$

$$Z_{base\,2} = \frac{V_{base}^2}{S_{base}}.$$

$$\Rightarrow Z_{base\,2} = \frac{(9600)^2}{50\times10^3}$$ [Substituting 9.6 KV for V_{base} & 50 KV_A for S_{base}].

$$= 1843.2\ \Omega$$

Substituting $j125\ \Omega$ for Z_{actual} & $1843.2\ \Omega$ for Z_{base2}.

$$Z_{2\,p.u} = \frac{j125}{1843.2}\ p.u. = 0.068j\ p.u.$$

Here, $Z_{p.u} = \frac{Z_{actual}}{Z_{base2}}$ for the expression per unit value of the transmission line impedance.

$\Rightarrow$ Substitute $(50+j200)\Omega$ for Z_{actual} & $1843.2\ \Omega$ for Z_{base2}

$$Z_{p.u} = \frac{50+j200}{1843.2} \text{ p.u.}$$

$$= 0.027 + 0.1085j \text{ p.u}$$

Subsititutite 25 KVA for KVA_{actual} & 50 KVA for KVA_{base}.

$$KVA_{p.u} = \frac{25}{50} \text{ p.u. } 0.5 \text{ p.u.}$$

Calculating the per unit voltage rating of motor:

$$K.V_{p.u} = \frac{KV_{actual}}{KV_{base}}$$

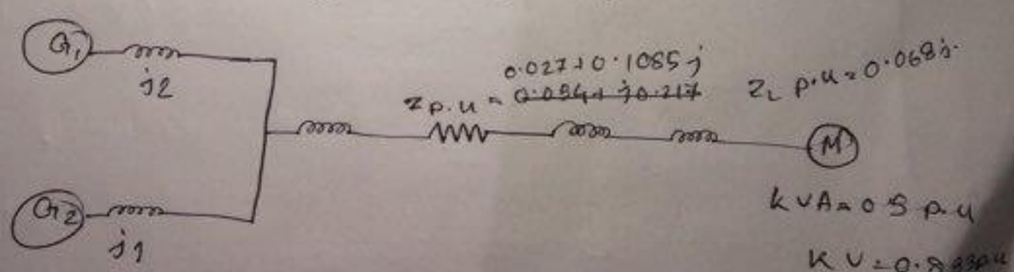
$$KV_{base} = \frac{5\times10^3}{10\times10^3}(9600).$$

$$= 4.8 \text{ KV}.$$

Substitute 4KV for KV_{actual} & 4.8 KV for KV_{base}.

$$K.V_{p.u} = \frac{4}{4.8} \text{ p.u}$$

$$= 0.833 \text{ p.u.}$$



Answer to question No: 2

Answer to question No:2.

The base MVA in the y circuit is 20MVA

$V_{base\ z} = \frac{138}{a} = 69\ kV.$

$Z_{base\ z} = \frac{69^2}{10} = 476.1\ \Omega.$

Determine the p.u impedance.

$Z_{p.u} = \frac{Z}{Z_{base\ z}} = \frac{200}{476.1} = 0.420\ p.u$

Determining base impedance in circuit Y.

$Z_{base\ y} = \frac{V^2_{base\ y}}{S_{base}} = \frac{138^2}{15} = 1269.6\ \Omega$

Determining the load impedance referred to Y-circuit.

$Z_y = (2)^2 \times 500 = 2000\ \Omega.$

$\therefore Z_{p.u} = \frac{2000}{1269.6} = 1.557\ p.u$

$V_{base\ x} = 138a.$

$= 138\left(\frac{1}{10}\right) = 13.8\ kV.$

$Z_{base\ x} = \frac{(13.8)^2}{15} = 12.69\ \Omega.$

Here $Z_v = a_1^2\ Z_y = \left(\frac{1}{10}\right)^2 (2000) = 20\ \Omega.$

$\therefore Z\ p.u = \frac{Z_x}{Z_{base\ x}} = \frac{20}{12.696} = 1575\ p.u.$

Answer to Question No: 4

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Choosing generator rating as the base MVA & KVA i.e 25 MVA, 13.8 kV.

Generator Reactance $x''_{d} = 15\% = 0.15$ pu.

Transformer T_1 : 25MVA = 13.2 | 69 kV, 11%.

25MVA, 13.8 KV are base.

New transformer reactance:

$$x_{T_1 new} = x_{T_1 old} \times \frac{MVA_{new}}{MVA_{old}} \times \left(\frac{KV_{(old)}}{KV_{(new)}}\right)^2$$

$$= 0.11 \times \left(\frac{25}{25}\right)\left(\frac{13.2}{13.8}\right)^2 \Rightarrow$$

$x_{T_1 new} = 0.1$ p.u

Both Transformers ratings are same.

$\therefore x_{T_1 new} = x_{T_2 new} = 0.1$ p.u

transmission reactance $x_{T_2} = x_{T_1}\,\Omega \times \frac{MVA}{KV^2}$

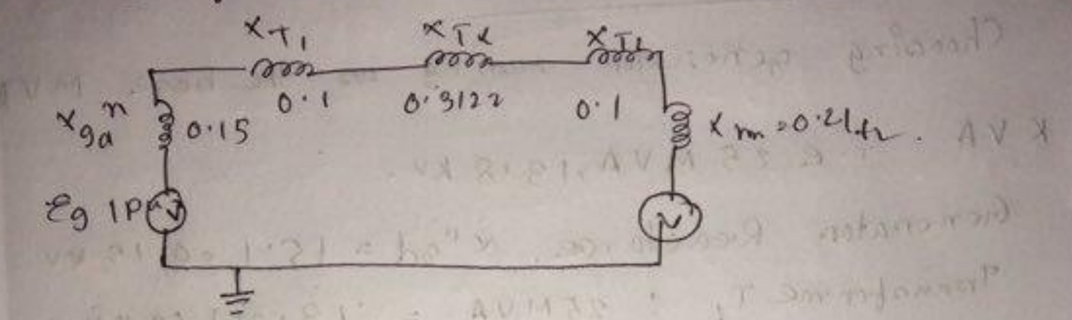
For, 13.2 KV — 69 KV

13.8 KV $\rightarrow$? $\frac{69 \times 13.8}{13.2} = 72.13$ kV.

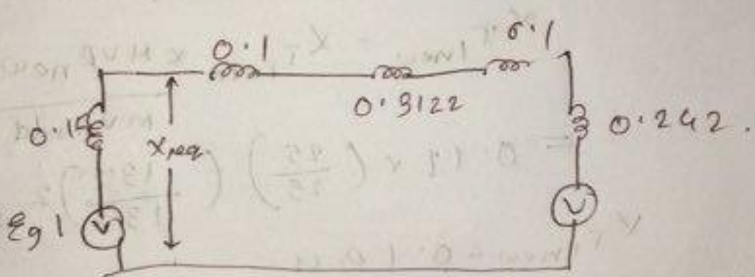
$x_{T_2} = 65 \times 25 / 172.812 = 0.3122$ p.u.

Motor reactance $= x_{md} = 0.15 \times \frac{25}{15} \times \left(\frac{13}{13.8}\right)^2 = 0.2172$ p.u

Finally, equivalent single line diagram



3 phase fault is occured on at the generator bus A . Then circuit is changed as below.



$$i_f = \frac{E_g}{x_{1eq}}.$$

$$x_{1eq} = 0.15 \parallel (0.1 + 0.3122 + 0.1 + 0.242)$$

$$= 0.15 \parallel 0.7546$$

$$= 0.1251$$

~~Subtr~~ fault current $= \frac{1}{0.124} = 7.90$ p

Base Current $= \frac{\text{Rated MVA}}{\text{Rated kV}}$

$$= \frac{25}{\sqrt{3} \times 13.8} = 1.0459 .$$

$\therefore I_b = 1045.9 A.$

transient fault current in ampere

$$I_f = I_{f(pu)} \times I_b .$$

$$= 7.99 \times 1045.9 .$$

$$= 8356.9 A = 8.3569 kA .$$