Al-Balqa University
Faculty of Engineering

Student Name:
Student Number:

Dept. of Electrical power Engineering
Mid-term Exam, Second Semester: 2016/2017

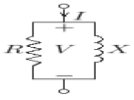
Course Title: Electric Power systems Analysis 1	**Date: 26/3/2017**
Course No: (315020481)	**Time Allowed: 90min.**
Lecturer: Dr's. Audih & Rami	**No. of Pages: 2**

Question1: ***[10marks]***

Objective: Solve and chooses the correct answer (2marks each one)

1) Y-connected load consisting of three identical impedance of $20\angle 30^{o}\Omega$ supplied by 4.4 kV_{LL}, the line impedance which supply the load is $Z_L=1.4\angle 75^{o}\Omega$, the **magnitude of voltage line** to neutral at substation is:
   (a) 4620V (b) 2669V (c) 1542V (d) None
2) In a balanced three-phase system with positive sequence ,the Y-connection impedances are $10\angle 30^{0}\ \Omega$, if $V_{bc}=416\angle 90^{0}$ V, the current I_{cn} is
   (a) $24.0\angle -90^{0}$A (b) $24.0\angle 30^{0}$A (c) $24.0\angle 120^{0}$A (d)None
3) If $N_1=500$ and $N_2=2000$ turns in single-phase transformer with $V_1=1200\ \angle 0^{0}$ and $I_1= 5\angle -30^{0}$A the impedance Z_2 is:
   (a) $3840\angle 30^{0}\Omega$ (b) $15\angle 30^{0}\Omega$ (c) $240\angle 30^{0}\Omega$ (d)None
4) The reactance of a generator designated is 0.25pu. at base rating of 18kV,500MVA the new reactance in pu. base of 20kV and 100MVA is:
   (a) 0.25pu (b) 0.0405pu (c) 0.0617pu (d) None
5) An inductive load consisting of R and X in parallel feeding from 2.4kVrms supply as in figure, absorbs 288 kW at a lagging power factor of 0.8. the reactance X value in ohm is :

   a)26.7 b)20 c)17.42 d)24.4



Question 2: ***(10Marks)***

***Objectives: General* Understanding the concepts of power system.**

Full in the blanks either **True or False** for the following: (one mark each point)

1) In three phase system we can control the rotation direction of the machine by increasing reactive power. False
2) Since the current $I_{ab}=I_{ba}$ then the magnitude of V_{ab} is equals to V_{ba} True
3) The delta impedance of three phase load is three times of Y connection True
4) when the current lead voltage then the power factor is lagging False
5) If reactive power is with negative sign, then the circuit absorbs reactive power from the network. False
6) For transformers the p.u. of impedances for primary is a half of secondary sides. False

7) *The impedance base in Ω when power is kVA and the voltage in kV is equal to* $\frac{V^2}{VA}$ False

8) The voltage of power system is controlled by excitation field of generator. True

9) In ideal transformer the leakage flux=∞ False

10) The self geometrical main distance of circle adjusts the radius in order to account for internal flux for solid conductor. True

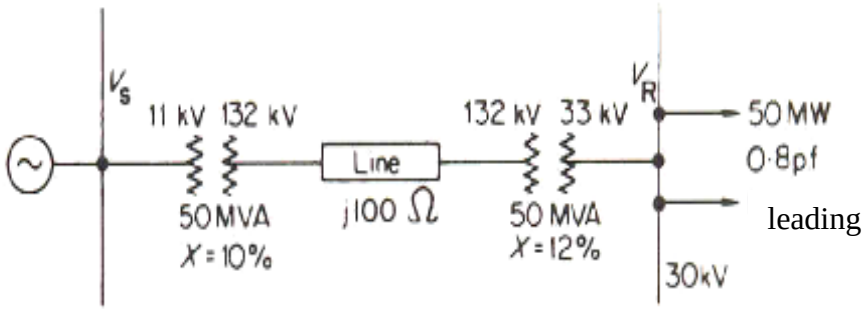
Question3: ***[10marks]***

Objective: This question is related to per-units quantities

In the schematic diagram of radial three- phase transmission system which contains the reactance of various component as showing in figure, along with the normal transformer line voltage .A load of 50MW at 0.8p.f. **leading** is taken from the 33kV substation which is to be maintained at 30kV. Calculate:

a) The terminal voltage of the synchronous machine. (7marks)

b) Represent the line and transformers by series reactance in per-unit (3marks)

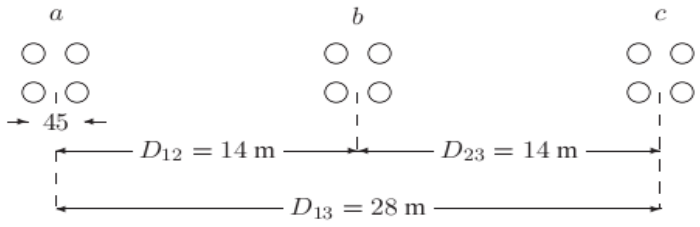


Question4: ***[10marks]***

Objective: This question related to inductance of transmission lines

A single-circuit 60 Hz three-phase transmission transposed line is composed of four ACSR conductor per phase with horizontal configuration as shown in Figure . The bundle spacing is 45 cm. The conductor 3.5103cm and GMR of 1.4173cm.

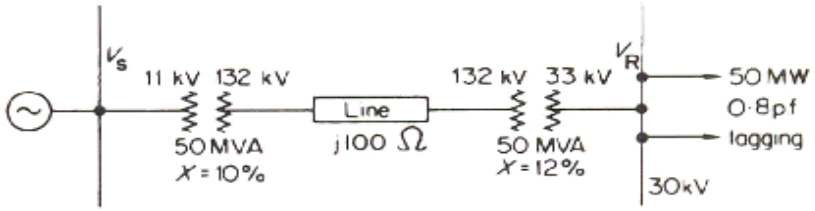
1- Determine the inductance per phase per kilometer of the line.



2- If the composed bundle is changed with three conductor per phase with same spacing ,what is the new inductance per pahse/km. (5marks)

Good luck

$Q3$ *Solution* :



$V_s = IZ + V_R$

We select $S_{base} = 50MVA$,

$V_{base\,(gene.)} = 11kV$, $V_{base\,(line)} = 132kV$, $V_{base\,(load)} = 33kV$

$a)\quad \Omega_{base} = \dfrac{(kV)^2}{MVA} = \dfrac{(132)^2}{50} = 348.48\Omega$

$|I_{base}| = \dfrac{S_{base}}{\sqrt{3}V_{base}} = \dfrac{50\times10^6}{\sqrt{3}\times33\times10^3} = 874.77A$

(note the angle base neglected),but in

actual value is taken as $\cos^{-1}(0.8) = +36.8^o$ *leading*

$I_{load} = \dfrac{P}{\sqrt{3}V_{LL}.\cos\phi} = \dfrac{50\times10^6}{\sqrt{3}\times30\times10^3\times0.8} = 1203\angle36.8^o\,A$

$I_{load\,(pu)} = \dfrac{acuate}{base} = \dfrac{1203\angle36.8^o}{874.77} = 1.375\angle36.8^0$

No change reactance base since $50MVA$ *is same as old*

$X_{pu,new} = X_{pu,old}\times\left(\dfrac{S_{base,new}}{S_{base,old}}\right) \Rightarrow X_{T_1(pu)} = j\,0.1\times\left(\dfrac{50}{50}\right) = j\,0.1$

$X_{T_2(pu)} = j\,0.12\times\left(\dfrac{50}{50}\right) = j\,0.12$

$X_{line} = \dfrac{actuale}{base} = \dfrac{j100}{348.48} = j\,0.287$

At the bus load the voltage base is $33kV$ $\Rightarrow$*The per* $-$*unit voltage* $=$

$= \dfrac{actuale}{base} = \dfrac{30kV}{33kV} = 0.91$

$V_s = IZ + V_R = 1.375\angle36.8^0\times(j\,0.287 + j\,0.12 + j\,0.1) + 0.91 = 0.744\angle48.6^o$

$**if\ \ the\ base\ S = 100MVA \quad then$

$$\Omega_{base} = \frac{(kV)^2}{MVA} = \frac{(132)^2}{100} = 174.24\Omega$$

$$|I_{base}| = \frac{S_{base}}{\sqrt{3}.V_{base}} = \frac{100\times10^6}{\sqrt{3}\times33\times10^3} = 1750A$$

$$X_{T_1(pu)} = j0.1\times\left(\frac{100}{50}\right) = j0.2$$

$$X_{T_2(pu)} = j0.12\times\left(\frac{100}{50}\right) = j0.24$$

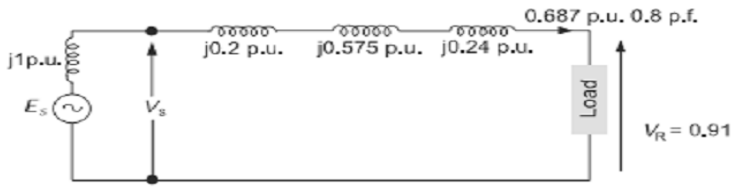
$$X_{line} = \frac{actuale}{base} = \frac{j100}{174.24} = j0.574$$

$$I_{load(pu)} = \frac{acuate}{base} = \frac{1203\angle36.8^o}{1750} = 0.687\angle36.8^0$$

$$V_R = \frac{30kV}{33kV} = 0.91$$

$$V_s = IZ + V_R = 0.687\angle36.8^0\times(j0.574 + j0.24 + j0.2) + 0.91 = 0.744\angle48.6^o$$

b)



Question4:

$$GMD = \sqrt[3]{(14)(14)(28)} = 17.63889 \text{ m}$$

and From (4.53) and (4.90), we have

$$GMR_L = 1.09\sqrt[4]{(1.4173)(45)^3} = 20.66 \text{ cm}$$

and from

$$L = 0.2\ln\frac{GMD}{GMRL} = 0.2\ln\frac{17.63889}{0.2066} = 0.889 \text{ mH/Km}$$