71/80 = 18/20

1) 10/10
2) 13/15
3) 30/35
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University of Jordan

Electrical Eng. Dept

EE 0933481 Power Systems (1) First Exam.

30-10-2014

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Q1) Draw the reactance diagram of the system which has the following Bus Admittance Matrix: **[10]**

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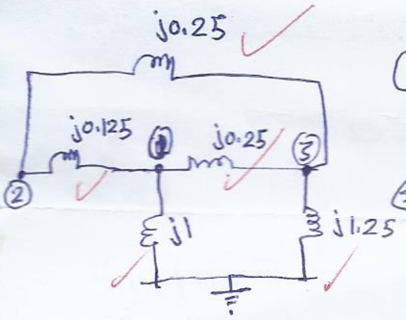
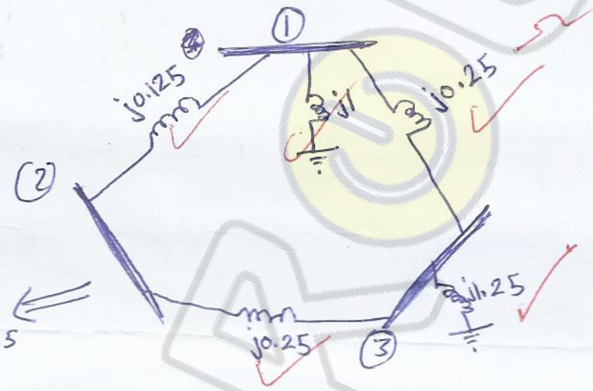
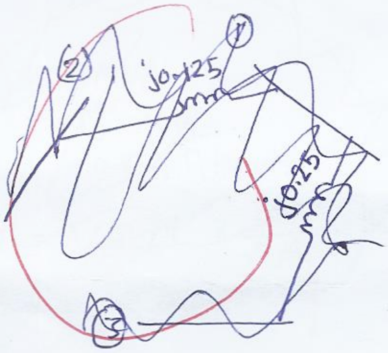
$$Y=\begin{bmatrix} -j13 & j8 & j4 \\ j8 & -j12 & j4 \\ j4 & j4 & -j8.8 \end{bmatrix}$$







Q2) A 60 Hz,3-ph cylindrical synchronous generator has the following parameters: L_S=2.77 mH M_f=31.7 mH

M_S=1.38 mH L_{ff}=434 mH

During balanced steady state operation, the armature and field current are as follows: $i_a=20\sin(\theta_d-30^0)$ kA i_f=4 kA

Evaluate λ_a at $\theta_d=60^0$ **[15]**

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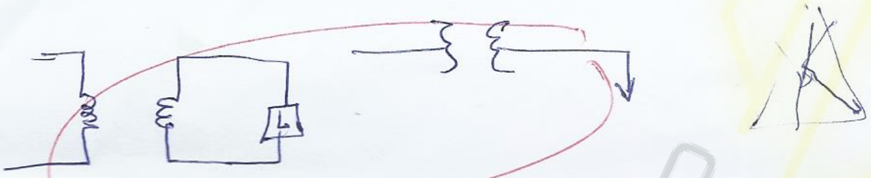
$|I_a| = \frac{20}{\sqrt{2}} = 14.142$

$\lambda_a = (L_s + M_s) i_a + M_f i_f \cos(\theta_d)$

$= (2.77m + 1.38m)(14.142k) + (31.7m)(4k)\cos(60)$

$= 122.1$

$\lambda_a = (L_s + M_s) i_a + L_f i_f \rightarrow M_f \cos(\theta_d)$



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Q3) A 3-ph transformer rated at 5 MVA, (115 y/13.2 Δ) kV and per-phase series impedance of $0.0753\angle 84.7^0$ pu. The transformer is supplying a balanced 3-ph load rated at 4 MVA, 13.2 kV and 0.85 pf lagging, through a transmission line which has a series impedance per phase of $0.102\angle 78.7^0$ pu on a base of 10 MVA and 13.2 kV.

By using base values of 10 MVA and 13.2 kV:

i) Evaluate and draw the pu impedance diagram of the system. [15]

ii) By assuming Negative Sequence evaluate the pu primary voltage of the transformer. [20]

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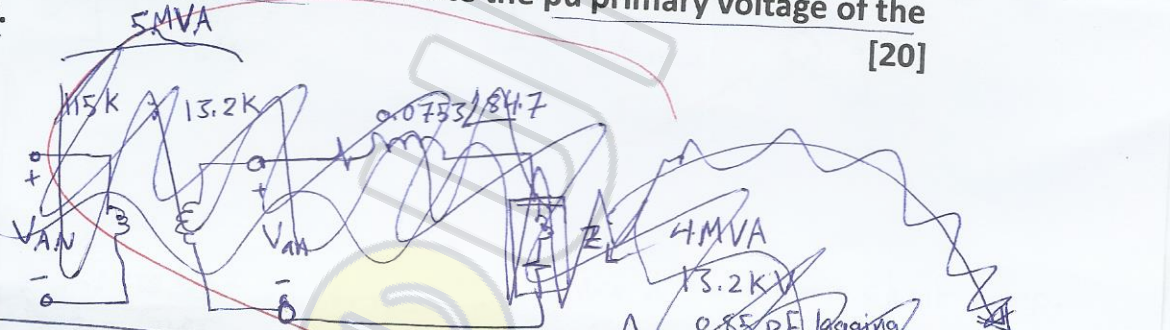

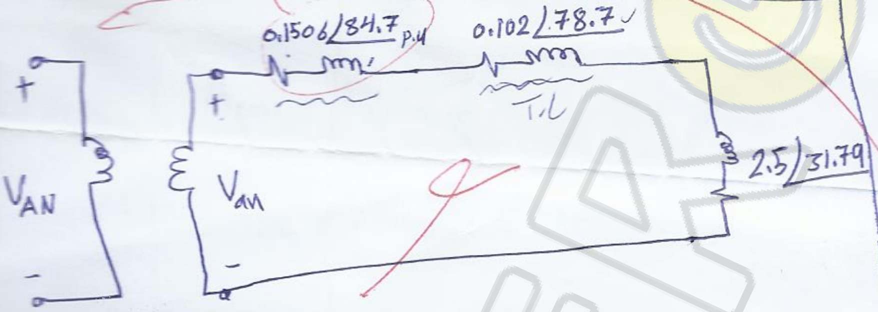

$T: Z_{new} = 0.0753\angle 84.7_{old} \times \frac{10}{5} = 0.1506\angle 84.7$

$T.L: Z = 0.102\angle 78.7$

$Load: Z_L = 1\angle 31.79 \times \frac{10}{4} = 2.5\angle 31.79$ p.u

$I_L = \frac{4M}{\sqrt{3} \times 13.2K} = 174.95\angle -31.79^\circ$ A

$I_{base} = \frac{10M}{\sqrt{3} \times 13.2K} = 437.39$

$I_{p.u} = 0.4\angle -31.79$ p.u

$V_{an} = 0.4\angle -31.79 \times (0.1506\angle 84.7 + 0.102\angle 78.7 + 2.5\angle 31.79)$

$= 1.067\angle 4.184$ p.u

$V_{AN} = V_{an}\angle -30 = 1.067\angle -25.816^\circ$ p.u $\times 115 = 122.7\angle -25.82$ V long

Q4) A 3-PH transmission line is 480 km long and having the following parameters: $A = D = 0.818\angle 1.3^0$, $B = 172.2\angle 84.2^0$, $C = 0.0001933\angle 20.4^0$. Design a compensation network to be located at the receiving end in such away to maintain the voltages at no-load as follows:

$V_S = 256.738\angle 20.15^\circ$ kV and $V_R = 218\angle 21.03^\circ$ kV [20]

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$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} 1 & 0 \\ \frac{1}{jX_L} & 1 \end{bmatrix} = \begin{bmatrix} A_{new} & B \\ C_{new} & D \end{bmatrix}$$

@ no load

$V_s = A_{new} V_R$

$\Rightarrow A_{new} = \frac{V_s}{V_R} = \frac{256.738\angle 20.15}{218\angle 21.03} = 1.1777\angle -0.88$ since A changes $\Rightarrow$ shunt comp.

$A_{new} = A_{old} + \frac{B}{jX_L}$ ← $B_{old} = B_{new}$

$1.1777\angle -0.88 = 0.818\angle 1.3 + \frac{172.2\angle 84.2}{jX_L}$

$\frac{172.2\angle 84.2}{jX_L} = 0.3616\angle -5.82$

$jX_L = 476.173\angle 90$

$\boxed{X_L \simeq 476.173}\ \Omega$

X_L = wL / L = 1.1