Q	Mark
1	3 /9
2	4 /6
3	7 /15
4	17 /20
5	8 /10
Total	39/60

$V_R = A V_s + B I_s$

$I_R = C V_s + D I_s$

$I = Y_{11} V_1 + Y_{22} V_2 \ldots$

University of Jordan

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EE 0933481 Power Systems (1) Firs Exam. 8-11-2015

الاسم: [redacted] رقم التفقد(47) الرقم الجامعي: [redacted]

Q1) A 4 busbar system has busbar number 3 connected to busbars 1 and 4 by means of medium length transmission lines. The lines have the following total Z (Ω) and Y(S):

Line 3-1: Z=0.0074+j 0.0372 ,Y= j0.0775

Line 3-4: Z=0.0127+j 0.0636 ,Y=j0.1275

Evaluate the elements Y_{13} and Y_{33} in the Bus Admittance Matrix of this system. [9].

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$1 + \frac{ZY}{2}$

$\begin{bmatrix} 1\angle -6.5\times10^{-3} & .038\angle 87.7 \\ 1\angle -6.4\times10^{-3} & .0774\,J \end{bmatrix}$

$Y_{13} = 1\angle -6.4\times10^{-3} = 9.94\times10^{-4} - 1.11\,J\times10^{-4}$

$Y_{13} = 26.36\angle -78.7$

$Y_{33} = 41.78\angle -78.7$

how!!

$V_S = A V_R + B I_R$

$I_S = C V_R + D I_R$

Q2) By drawing the electrical circuit showing on it all necessary voltages and currents, sketch the phasor diagram of the Ferranti effect. [6]

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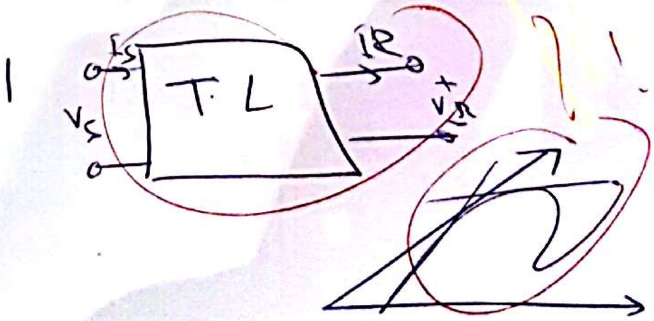
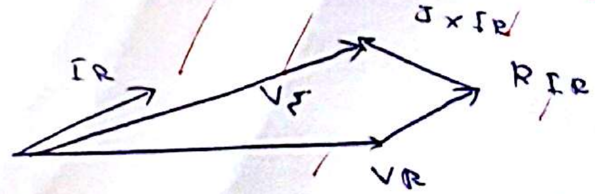


cct. ?!

I_R leads V_R

$|V_S| < |V_R|$



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Q3) The components of the power system shown in Fig. 1, has the following reactance in pu referred to the same base:

Component:	G_1	G_2	T_1	T_2	TL12	TL13	TL23
Reactance :	0.2	0.2	0.05	0.05	0.1	0.1	0.1

a- If the transmission lines of short length, draw the detailed pu reactance diagram of the system by assuming positive phase sequence. [6]

b- If the current into busbar 5 is $0.9\angle{-120^0}$ pu and the voltage at busbar 5 is $0.8\angle{-30^0}$, then by using (a) above evaluate the current into busbar 2 and the voltage at busbar 2. [9]

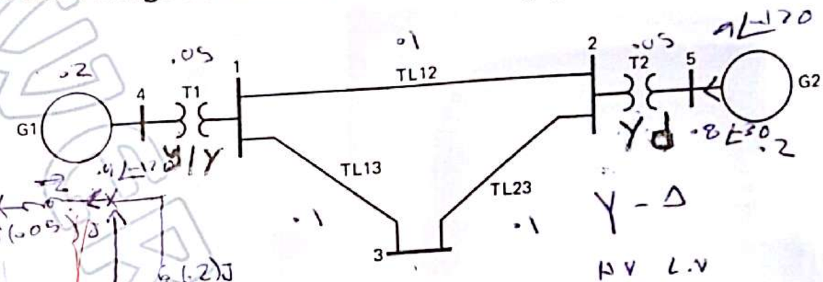
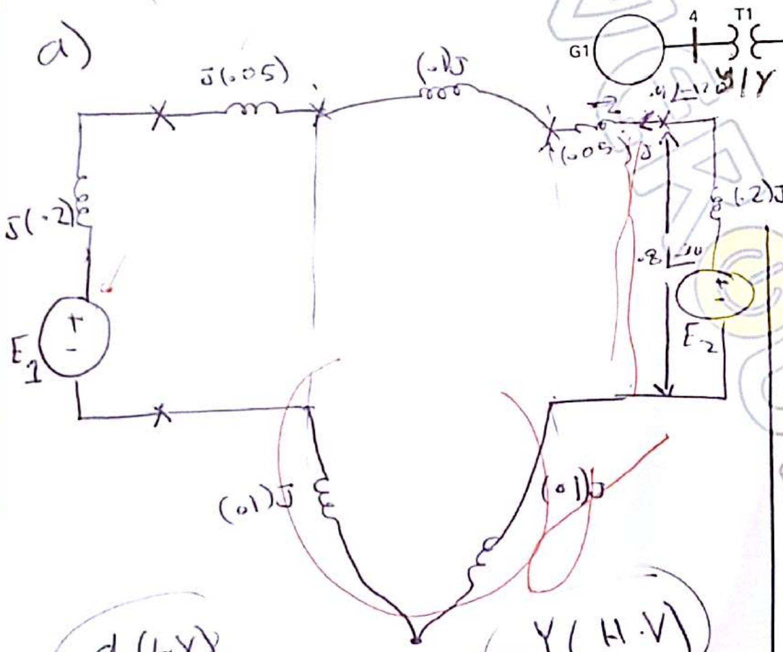


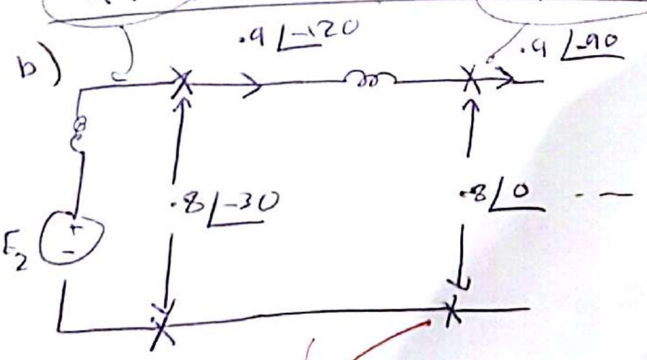
Fig. 1

a)



d (L.V)   Y (H.V)

b)



$V_2^{(1)} = V_1^{(1)}\angle 30$

$.8\angle 0 = V_2$

$.9\angle -90 = I_2$

$\cosh \gamma L$ $\quad Z_c \sinh \gamma L$

$\frac{1}{Z_c} \sinh \gamma L$ $\quad \cosh \gamma L$

[redacted]

Q4) A 50 Hz, 300 km transmission line has its phase conductors equally spaced with distance between centers =1.5 m. The line has the following data:

D_s =0.387 cm, radius of conductor= 0.8 cm, R= 0.237 Ω/km.

Given ε =8.85*10^{-12}, evaluate the A constant of this line. [20]

Long

D

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$\cosh \gamma L$

a) Find L: $2 \times 10^{-7} \ln\left(\frac{D}{D_s}\right)$

$\Rightarrow 2 \times 10^{-7} \cdot \ln\left(\frac{1.5\ 15}{.387}\right)$

$$\boxed{L = 7.3 \times 10^{-7}\ H/m}$$

b) Find C: $\frac{2\pi\epsilon}{\ln\left(\frac{D}{r}\right)}$

$$\Rightarrow \frac{2\pi \times 8.85 \times 10^{-12}}{\ln\left(\frac{1.5}{.8}\right)}$$

$$\boxed{C = \cancel{1.80}\ 1.9 \times 10^{-11}\ F/m}$$

c) $\cancel{L}\ X = jwL$

$\Rightarrow j\,2\pi \times 50 \times 7.3 \times 10^{-7}$

$X = 2.3 \times 10^{-4}\ j\ \Omega/m$

$Y = jwC \Rightarrow (2\pi \times 50 \times 1.9 \times 10^{-11})j$

$= 5.9 \times 10^{-9}\ j\ \mho/m$

$Z_{tot} = (237 + 69j)\ \Omega$

$Y_{tot} = (1.77 \times 10^{-3} j)\ \Omega$

$\gamma L = \sqrt{(Z\ C)L}$

$\Rightarrow \gamma L = \sqrt{(237 + 69j) \times (1.77 \cdot 10^{-3} j)}$

$= \sqrt{.43691 \angle 106.2}$

$\Rightarrow .660992 \angle 53.1$

$A = \cosh \gamma L$

$= \frac{e^{\gamma L} + e^{-\gamma L}}{2}$

$e^{\gamma L} = e^{.660992 \angle 53.1}$

$= e^{.39687}\ e^{.52858j}$

$\Rightarrow 1.487 \angle 30.3$

$e^{-\gamma L} = .67242 \angle -30.3$

$A = \frac{1.487 \angle 30.3 + .67742 \angle -30.3}{2}$

$\Rightarrow .954596 \angle 12.431$

$V_S = A V_R + B I_R \Rightarrow \frac{V_S}{B} - \frac{A V_R}{B} = I_R$

$\angle\beta-\delta \quad \angle\beta\alpha \quad \angle\delta-\beta \quad \angle\alpha-\beta$

$\frac{V_S}{B} V_R - \frac{A V_R^2}{B}$

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[redacted]

Q5) For the transmission line whose equivalent circuit is shown in Fig. 2, if $V_S = 138\angle 28^0$ kV and $V_R = 125\angle 0^0$ kV, evaluate:

a-the maximum power it can deliver [7]

b-Its voltage regulation. [3]

$$\begin{bmatrix} V_S \\ I_S \end{bmatrix} = \begin{bmatrix} 1 + \frac{ZY}{2} & Z \\ Y + \frac{ZY^2}{4} & 1 + \frac{ZY}{2} \end{bmatrix} \begin{bmatrix} V_R \\ I_R \end{bmatrix}$$

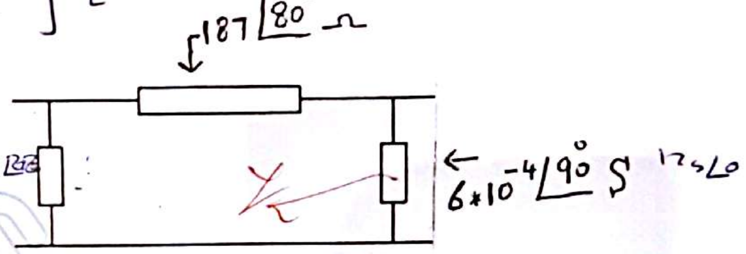

FIG.2

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$\left[\ \cancel{.9422}\ \angle 170 \right.$

$1 + \frac{187\angle 80 + (6\times10^{-4} j)}{2}$

$A \& D \quad \boxed{= .9448\ \angle .59}$

$C = 5.83 \times 10^{-4} \angle 90.3$

$B = 187\angle 80$

$$\begin{bmatrix} V_S \\ I_S \end{bmatrix} = \begin{bmatrix} .9448\angle .59 & 187\angle 80 \\ 5.83\times10^{-4}\angle 90.3 & .9448\angle .59 \end{bmatrix} \begin{bmatrix} V_R \\ I_R \end{bmatrix}$$

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$\frac{|A||V_R|^2}{|B|}$ $\quad \beta-\alpha \quad \frac{|V_S||V_R|}{|B|} \quad \frac{|A||V_R|}{|B|}\angle\beta \quad \delta-\beta$

$\vec{B} = \angle\beta \qquad \vec{A} = \angle\alpha$

① $\frac{|V_S||V_R|}{|B|} - \frac{|A||V_R|^2}{|B|}\cos(\beta-\alpha)$

$\frac{138 \times 125}{187} - \frac{.9448 \times 125^2}{187}\cos(80-.59)$

$P_{max} = 77.7377$ MW

② $VR = \frac{|V_{RNL}| - |V_{RFL}|}{|V_{RFL}|}$

$V_{RNL} = \frac{|V_S|}{|A|} \Rightarrow \frac{138}{.9448}$

$= 146.06$

$V_{RFL} = 125$

$VR = \left(\frac{146.06 - 125}{125}\right) \times 100$

$= 16.848\%$