Q	Mark
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3	6/18
4	4/16
	35/60

$\gamma = \sqrt{zy}$

University of Jordan

Electrical Eng. Dept

EE 0933481 Power Systems (1) **Second Exam.**

17-4-2016

الاسم: [redacted] رقم التفقد (6) الرقم الجامعي: [redacted]

Q1) a-The series impedance of the equivalent circuit of a long transmission line has a value of Z = 187 $\angle 79^0$ Ω. If the product of line's length and propagation constant equal 0.5 $\angle 85^0$,evaluate the characteristic impedance of the line. **[8]**

$\gamma l = 0.5\angle 85 = 0.0437 + j0.5$

$\gamma l = 0.5 \angle 85^\circ$

$A = D = \cos(\gamma l) = \frac{1}{2}\left(e^{\gamma l} + e^{-\gamma l}\right)$;

$e^{\gamma l} = e^{0.0413} e^{j0.5} = 1.04 \angle 28.6$

$e^{-\gamma l} = 0.96 \angle -28.6$

$= 0.878 \angle 1.25^\circ$

$\gamma l = \sqrt{ZY} = 0.5\angle 85 = 0.5 e^{j85} \Rightarrow ZY = 0.25 \angle 170$

$\Rightarrow Y = 1.33m \angle 91$

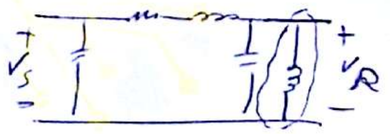
$B = Z_c \sinh(\gamma l)$; $Z_c = 374.9 \angle -6$; $B = 180 \angle 79.8$

$\hookrightarrow \frac{1}{2}\left(e^{\gamma l} - e^{-\gamma l}\right)$

$C = \frac{1}{Z_c} \sinh(\gamma l) = 1.28 \times 10^{-3} \angle 91.8$

b-Evaluate the parameter matrix of a compensation network with 80 % compensation factor located at the end of a lightly loaded transmission line which has series impedance of 180 $\angle 75^0$ Ω and shunt admittance of j 0.0012 S. **[5]**

$0.8 = \frac{B_L}{B_C}$, $B_C = j0.0012\ S$



$B_L = -j9.6 \times 10^{-4}\ S$

$\begin{bmatrix} 1 & 0 \\ B_L & 1 \end{bmatrix}$

$Z = \frac{X}{2}$

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$$V_1 = V_f\left(1 - \frac{Z_{13}}{Z_{33}}\right)$$

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Q2) A power system has 4 buses. For a balanced 3-ph at bus 3, the pu fault current was $5.118\angle -90^0$ and the voltages at busbars 1, 2 and 4 were 0.209, 0.235 and 0.465 respectively all in pu.

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a-Evaluate ΔV_1 [5]

$$I_f'' = \frac{V_f}{Z_{33}} \Rightarrow Z_{33} = 0.195\angle 90$$

I_f'' —
$V_f = 1\angle 0$

$$\Delta V_1 = -V_f \frac{Z_{13}}{Z_{33}} \Rightarrow -0.7897$$

$$V_1 = V_f\left(1 - \frac{Z_{13}}{Z_{33}}\right) \Rightarrow +0.791 = +\frac{Z_{13}}{Z_{33}}$$

$$Z_{13} = 0.154\angle 90$$

b-If the line between buses 3 and 4 has an impedance equal Numerically to the element Z_{43} in the Z_{bus} matrix, evaluate the current I_{34}. [8]

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$$V_4 = V_f\left(1 - \frac{Z_{43}}{Z_{33}}\right) \Rightarrow +0.535 = +\frac{Z_{43}}{0.195\angle 90}$$

$$Z_{43} = 0.104\angle 90$$

$$I_{34} = \frac{V_3 - V_4}{Z_{43}} = \frac{0 - 0.465}{0.104\angle 90} = 4.47\angle 90$$

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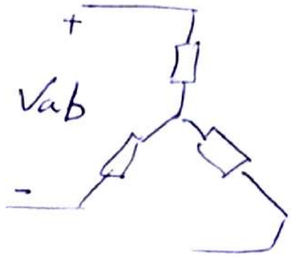
Q3)a- Prove that for a Y-connected system, its line voltages have NO Zero sequence components. [5]

$V_{ab} + V_{bc} + V_{ca}$

$(V_{ab}^0 + V_{ab}^1 + V_{ab}^2) + (V_{bc}^0 + V_{bc}^1 + V_{bc}^2)$

$+ (V_{ca}^0 + V_{ca}^1 + V_{ca}^2)$



$$\begin{bmatrix} V_{ab} \\ V_{bc} \\ V_{ca} \end{bmatrix} = A \begin{bmatrix} V_{ab}^0 \\ V_{ab}^1 \\ V_{ab}^2 \end{bmatrix}$$

$\Rightarrow I_a^0 = 0$

b-A balanced Y-connected load with isolated neutral has a pu impedance of 1 $\angle 20^0$ per phase.If its pu voltages are given as:

$V_{ab}^{(1)} = 0.98\angle 75^0$ $V_{ab}^{(2)} = 0.23\angle 220^0$

Use the concept of symmetrical components to evaluate the complex power supplied to load. [13]

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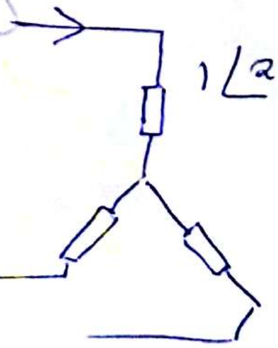
$S = (V_a^0 I_a^{0*} + V_a^1 I_a^{1*} + V_a^2 I_a^{2*})$ 3

$V_{ab}^1 = \sqrt{3}\angle 30^0\, V_{an}^1 \Rightarrow V_a^1 = 0.56\angle 105$

$V_{ab}^2 = \sqrt{3}\angle 30\, V_{an}^2 \Rightarrow V_a^2 = 0.133\angle -170$

$I_a^1 = \frac{0.56\angle 105}{1\angle 20} = 0.56\angle 85$



$I_a^2 = \frac{0.133\angle -170}{1\angle 20} = 0.133\angle 170$

$S = 0.331$ Pu

Q4) Fig. 1 shows the pu zero sequence network of a given power system, Where between each indicated 2 points there is one component.

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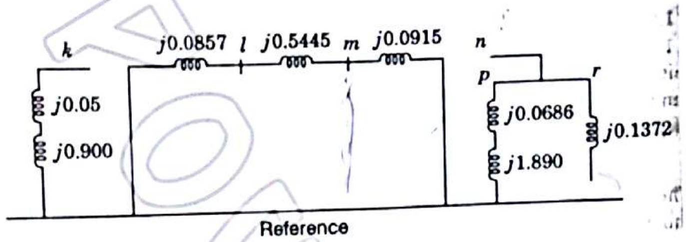
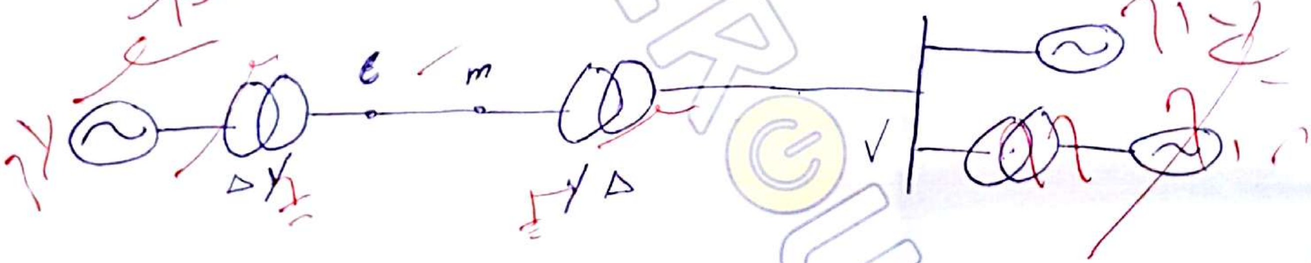


Fig. 1

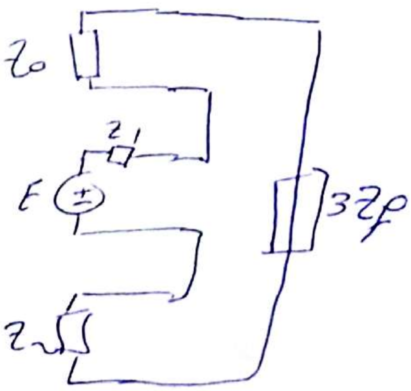
2/10 a-Draw the corresponding single-line diagram of the system. [10]



2/6 b-If for a fault at point m, $I^{(0)} = 0.5\angle 30^0$ PU, evaluate $V^{(0)}$. [6]

$I^0 = I^1 = I^2 = 0.5\angle 30$

$V_0^0 = -I^0 Z_0$; $Z_0 = j0.5445$



$V^0 = 0.2722\angle 120$