KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

ELECTRICAL ENGINEERING DEPARTMENT

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EE 463

MAJOR EXAM # II

May 7th , 2006

6:30 - 8:00 pm

Key Solution

Section:

Student Name:

Student I.D.#

Serial #:

Question # 1	
Question # 2	
Question # 3	
Total	

Q. 1) A three-phase synchronous generator is connected to a step-up three-phase transformer T_1 , which is connected to a 60-km-long transmission line. At the far end of the line, a step-down transformer bank T_2 is connected. The secondary of T_2 supplies two motor loads M_1 and M_2. The ratings of the various types of equipment are

Generator: 10 MVA; 12 kV; X = 20%; wye

T_1: 5 MVA; 12/69 kV; X = 10%; delta-wye

T_2: 5 MVA; 69/4.16 kV; X = 10%; wye-delta

M_1:2 MVA; 4.16 kV; X = 20%; wye

M_2:1 MVA; 4.16 kV; X = 20%; wye

Transmission line: X = 0.5 Ohm/km

For a three-phase fault on the low-voltage terminals of transformer T_2, calculate the short-circuit current in amperes supplied by the generator assuming that all internal voltages are 1.0 pu. (Choose the generator ratings as bases in the generator circuit.)

(40 Marks)

(a) $S_b = 10 \text{ MVA}$

$V_{bg} = 12 \text{ kV}$, $I_{bg} = \frac{10{,}000}{\sqrt{3}\,(12)} = 481 \text{ A}$

$V_{b\ell} = 69 \text{ kV}$, $Z_{b\ell} = \frac{(69)^2}{10} = 476.1\ \Omega$

$V_{bm} = 4.16 \text{ kV}$

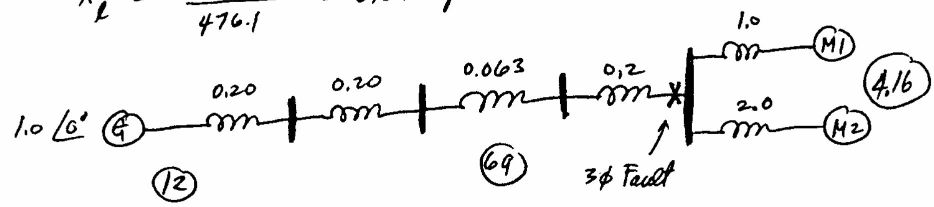
$X_{T1} = (0.10)\left(\frac{10}{5}\right) = 0.20 \text{ pu}$

$X_{T2} = (0.10)\left(\frac{10}{5}\right) = 0.20 \text{ pu}$

$X_{m1} = (0.20)\left(\frac{10}{2}\right) = 1.0 \text{ pu}$

$X_{m2} = (0.20)\left(\frac{10}{1}\right) = 2.0 \text{ pu}$

$X_\ell = \frac{(0.5)(60)}{476.1} = 0.063 \text{ pu}$



(b) $I_{Fg} = \frac{1.0\angle 0^\circ}{j(0.2+0.2+0.063+0.2)} = -j1.508 \text{ pu}$

$= (1.508)(481) = 725 \text{ A}$

Q. 2-a) Obtain the three phase currents of the following sequence components of the current in a

a portion of an unbalanced power system:

$I_{a1} = 2.5 \angle -90^o$ pu $\quad I_{a2} = 1.65 \angle 90^o$ pu $\quad I_{a0} = 0.85 \angle 90^o$ pu

(15 Marks)

$$I_a = I_{ao} + I_{a1} + I_{a2} = 0.85\angle 90° + 2.5\angle -90° + 1.65\angle 90° = 0$$

$$I_b = I_{ao} + a^2 I_{a1} + aI_{a2}$$

$$= 0.85\angle 90° + 1\angle 240°\ 2.5\angle -90° + 1\angle 120°\ 1.65\angle 90°$$

$$= 3.81\angle 160.5° \text{ pu} = -3.591 + j1.272$$

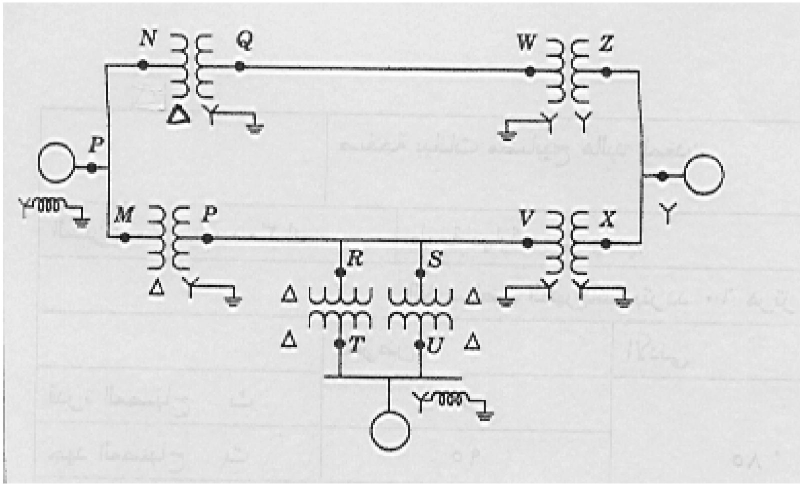
$$I_c = I_{ao} + aI_{a1} + a^2 I_{a2}$$

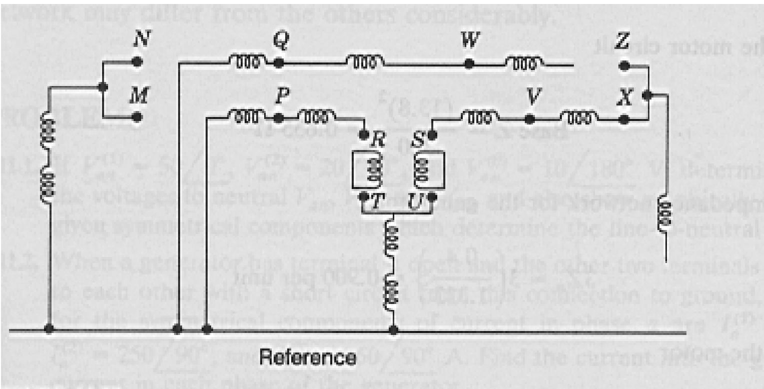
$$= 0.85\angle 90° + 1\angle 120°\ 2.5\angle -90° + 1\angle 240°\ 1.65\angle 90°$$

$$= 3.81\angle 19.5° \text{ pu} = 3.591 + j1.272$$

Q. 2-b) Draw the zero sequence equivalent circuit of the system shown below,

(15 Marks)





Q. 3) A generator having a solidly grounded neutral and rated 50-MVA, 30-kV has positive-, negative-, and zero-sequence reactances of 25, 15, and 5 percent, respectively. What reactance must be placed in the generator neutral to limit the fault current for a bolted (i.e., solidly grounded) line-to-ground fault to that for a bolted three-phase fault

(30 Marks)

The generator base impedance is

$$Z_B = \frac{(30)^2}{50} = 18 \ \ \Omega$$

The three-phase fault current is

$$I_{f\,3\phi} = \frac{1}{0.25} = 4.0 \ \ \text{pu}$$

The line-to-ground fault current is

$$I_{f\,LG} = \frac{3}{0.25 + 0.15 + 0.05 + 3X_n} = 4.0 \ \ \text{pu}$$

Solving for X_n, results in

$$\begin{aligned} X_n &= 0.1 \quad \text{pu} \\ &= (0.1)(18) = 1.8 \ \ \Omega \end{aligned}$$