KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

ELECTRICAL ENGINEERING DEPARTMENT

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EE 463

MAJOR EXAM # 1

March 29, 2006

11:45am - 1:00 pm

Key Solution

Section:

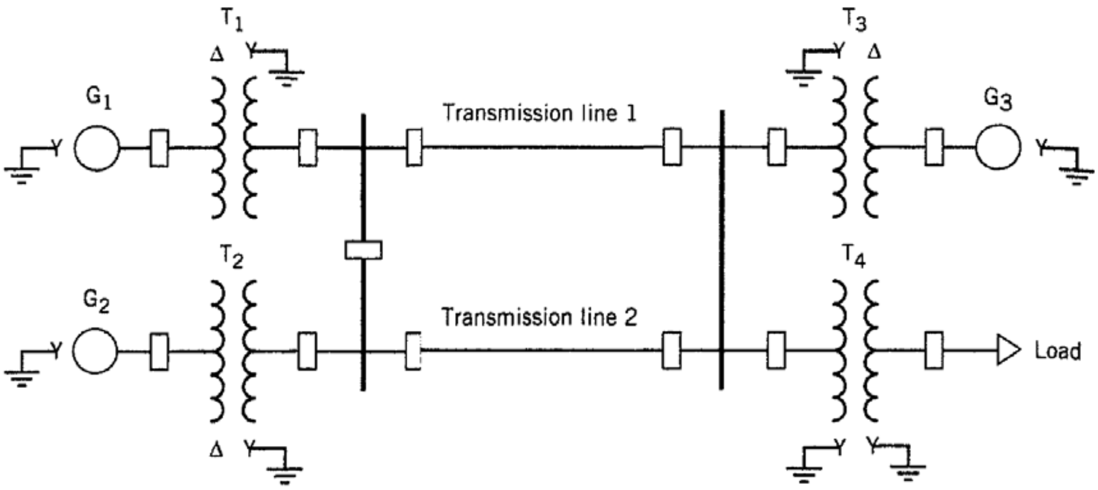
Student Name:

Student I.D.#

Serial #:

Question # 1	
Question # 2	
Question # 3	
Total	

Q. 1) The one-line diagram of a 2-bus power system is shown below.



The reactance of each transmission line is X = 20 Ohm. The generators and transformers are rated as follows:

G1: 20 MVA, 12 kV, X = 1.20 per unit
G2: 60 MVA, 13.8 kV, X = 1.40 per unit
G3: 50 MVA, 13.2 kV, X = 1.40 per unit
T1: 25 MVA, 12/69 kV, X = 0.08 per unit
T2: 75 MVA, 13.8/69 kV, X = 0.16 per unit
T3: 60 MVA, 13.2/69 kV, X = 0.14 per unit
T4: 75 MVA, 13.8/69 kV, X = 0.16 per unit

a) Choose a power base of 100 MVA and a voltage base of 12 kV in the circuit of generator G1, and assume that the circuit breaker between transformer 4 and the load is open. Draw the reactance diagram showing all the values in per units according to the new selected base values.
b) Form the bus admittance matrix Y_{bus}.

(50 Marks)

Solution:

a)

X_{G1} = 1.2 (100 / 20) = 6.0 p.u.

X_{G2} = 1.4 (100 / 60) = 2.333 p.u.

X_{G3} = 1.4 (100 / 50) = 2.8 p.u.

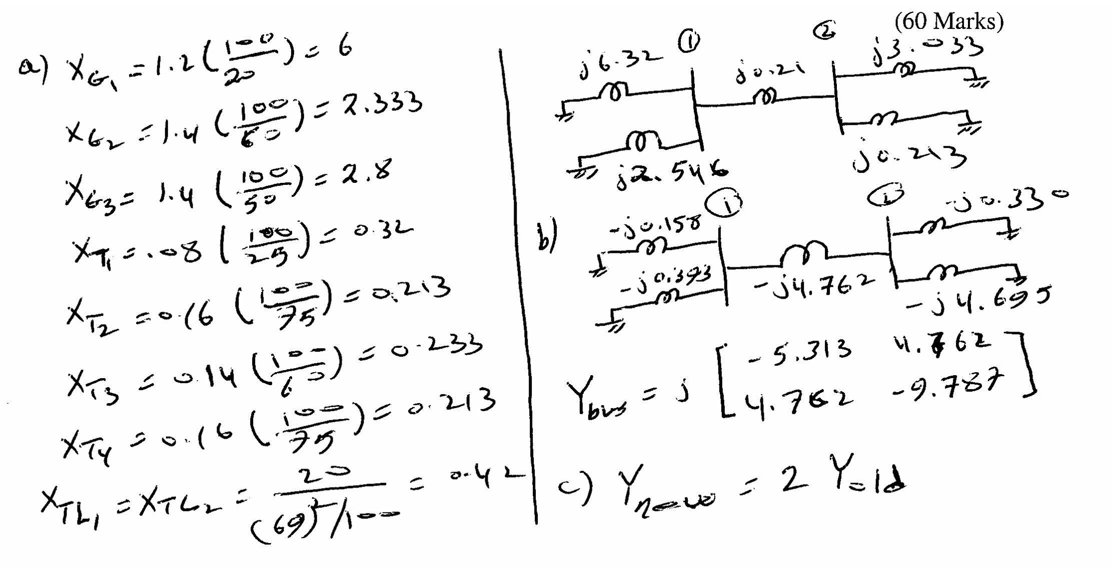
X_{T1} = 0.08 (100 / 25) = 0.32 p.u.

X_{T2} = 0.16 (100 / 75) = 0.213 p.u.

X_{T3} = 0.14 (100 / 60) = 0.233 p.u.

X_{T4} = 0.16 (100 / 75) = 0.213 p.u.

$X_{TL1} = X_{TL2}$ = 20 / (69^2 / 100) = 0.42 p.u.



b) $\mathbf{Y_{bus}} = j \begin{bmatrix} -5.313 & 4.762 \\ 4.762 & -9.787 \end{bmatrix}$

Q.2) Write down the equations of the 7th iteration, using Gauss-Seidel Iterative method with acceleration factor, of a nine-bus system for the following busses:

a) bus-3 (PQ-bus) connected to bus-1 (PQ-bus), bus-2 (slack-bus) and bus-6 (PV-bus).
b) bus-6 (PV-bus) connected to bus-2 (slack-bus), bus-3 (PQ-bus), bus-4 (PV-bus), and bus-9 (PQ-bus).

(Notice: define the voltage of a calculated PV-bus as V_{corr} , and an accelerated voltage as V_{acc})

(30 Marks)

Solution:

a)
$$V_3^7 = \frac{1}{Y_{33}}\left[\frac{P_3 - jQ_3}{V_{3acc}^{6*}} - \left(Y_{31}V_{1acc}^7 + Y_{32}V_2 + Y_{36}V_{6corr}^6\right)\right]$$

$$\Delta V_3^7 = V_3^7 - V_{3acc}^6$$

$$V_{3acc}^7 = V_{3acc}^6 + \alpha \Delta V_3^7$$

b)
$$V_6^7 = \frac{1}{Y_{66}}\left[\frac{P_6 - jQ_{6cal}}{V_{6corr}^{6*}} - \left(Y_{62}V_2 + Y_{63}V_{3acc}^7 + Y_{64}V_{4corr}^7 + Y_{69}V_{9acc}^6\right)\right]$$

where

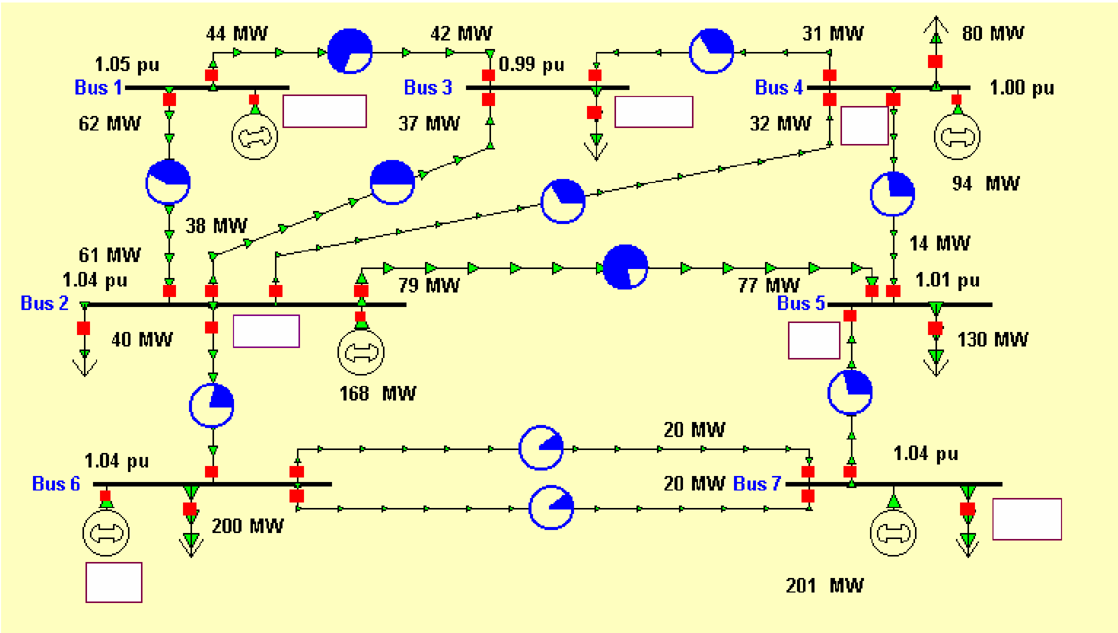
$$Q_{6cal} = -\operatorname{Im}\left[V_{6corr}^{6*}\left(Y_{62}V_2 + Y_{63}V_{3acc}^7 + Y_{64}V_{4corr}^7 + Y_{66}V_{6corr}^6 + Y_{69}V_{9acc}^6\right)\right]$$

$$\Delta V_6^7 = V_6^7 - V_{6corr}^6$$

$$V_{6acc}^7 = V_{6corr}^6 + \alpha \Delta V_6^7$$

$$V_{6corr}^7 = |V_6| \angle \theta_{6acc}^7$$

Q.3) The power flow of a 7-bus system is shown below



Assuming the following line losses :

Line	Real Power Loss (MW)
2-4	0
2-6	0
3-4	0
5-7	1
6-7	0
6-7	0

Find the real power in MW at the locations indicated with the empty rectangular boxes

(20 Marks)

Solution:

G1	=	106	MW
G6	=	200	MW
L3	=	110	MW
L7	=	201	MW
2-6	=	40	MW
4-5	=	15	MW
7-5	=	39	MW