Arab Academy for Science and Technology

Electrical and Computer Control Department

Power System II (EE 441) sheet (I)

1- A 60 Hz, alternating voltage having a RMS value of 100 V is applied to a series R-L circuit by closing a switch. The resistance is 15 Ω and the inductance is 0.12 H. Determine the following:

a) The value of dc component of current upon closing the switch if the instantaneous value of the voltage is 50 V at that time

b) The instantaneous value of the voltage which will produce the maximum dc component of current upon closing the switch

c) The instantaneous value of the voltage which will result in the absence of any dc component of current upon closing the switch

d) If the switch is closed when the instantaneous voltage is zero, find the instantaneous current 0.5, 1.5, 5.5 cycles later

2- A 60 Hz generator is rated 500 MVA, 20 kV with X_d''=0.2 per unit. It supplies a purely resistive load of 400 MW at 20 kV. The load is connected directly across the terminals of the generator. If all three phases of the load are short circuited simultaneously, find the initial symmetrical rms current in the generator in per unit on a base of 500 MVA, 20 kV.

3- A generator is connected through a transformer to a synchronous motor. Reduced to the same base, the per-unit sub-transient reactance of the generator and motor are 0.15 and 0.35 per unit respectively, and the leakage reactance of the transformer is 0.1 per unit. A three phase fault occurs at the terminal of the motor when the terminal voltage of the generator is 0.9 per unit and the output current of the generator is 1 per unit at 0.8 leading power factor. Find the sub-transient current in per unit in the fault, in the generator and in the motor. Use the terminal voltage of the generator as the reference phasor and obtain the solution a) by computing the voltage behind sub-transient reactance in the generator and motor and b) by using Thevenin's theorem.

4- For the network shown below in figure 1, find the sub-transient current in per unit from generator 1 and in line 1-2 and the voltages at buses 1 and 3 for a three phase fault on bus 2. Assume that no current is flowing prior to the fault and that the pre-fault voltage at bus 2 is 1 ∟0 per unit. Use the bus impedance matrix or bus admittance matrix to solve this problem, all values in the figure are impedances in p.u.

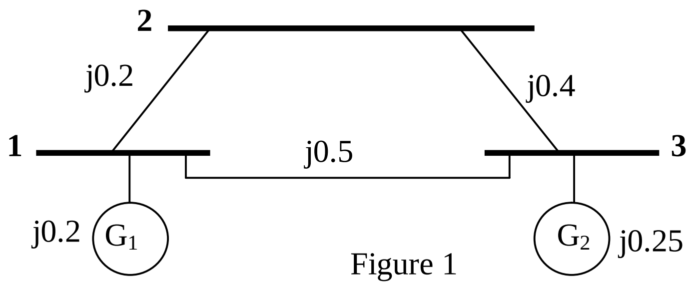

Figure 1

5- If a three phase fault occurs at bus 1 of the network shown in figure 2 when there is no load (all bus voltage equal to 1 ∟0 per unit), find the sub-transient current in the fault, the voltages at buses 2, 3, and 4 and the current form the generator connected to bus 4. The Z-bus matrix is given as

$$\text{Zbus}=\begin{bmatrix} j0.2436 & j0.1938 & j0.1544 & j0.1456 \\ j0.1938 & j0.2295 & j0.1494 & j0.1506 \\ j0.1544 & j0.1494 & j0.1954 & j0.1046 \\ j0.1456 & j0.1506 & j0.1046 & j0.1954 \end{bmatrix}$$

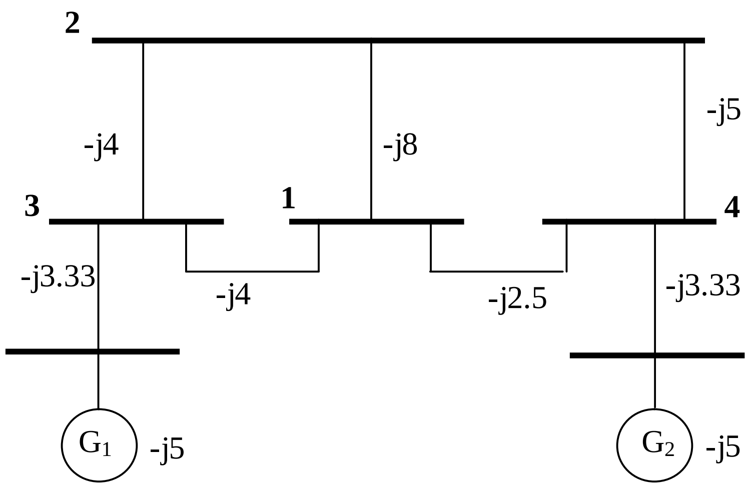

Figure 2

6- For the network sown in figure 3, the bus impedance matrix is given below. If a short circuit fault occurs at bus 2 of the network when there is no load (all bus voltage equal to 1 ∟0 per unit), find the sub-transient current in the fault, the voltages at bus 1 and 3 and the current from the generator connected to bus 1. All values in figure 3 are admittances in p.u.

$$\text{Zbusnl}=\begin{bmatrix} j0.079 & j0.05 & j0.038 & j0.0511 & j0.0608 \\ j0.05 & j0.1338 & j0.0664 & j0.063 & j0.0605 \\ j0.038 & j0.0664 & j0.0875 & j0.072 & j0.0603 \\ j0.0511 & j0.063 & j0.072 & j0.2321 & j0.1002 \\ j0.0608 & j0.0605 & j0.0603 & j0.1002 & j0.1301 \end{bmatrix}$$

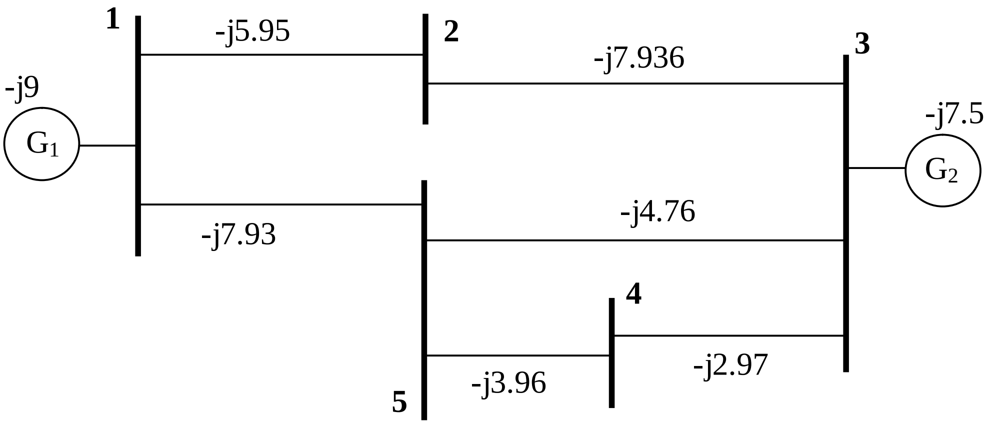

Figure 3

7- The network shown in figure 4 shows the one line diagram of a single power network which has the bus impedance matrix as given below. Each generator connected to buses 1 and 4 has a sub-transient reactance of 0.25 per unit, all line impedances are shown in p.u.Making the usual fault study assumptions, determine the sub-transient current in per unit in a three phase fault on bus 3 and the contributions to the fault current from 1 to 3 and from line 4 to3.

$$Zbus=\begin{bmatrix} j0.135713 & j0.123386 & j0.127806 & j0.114287 \\ j0.123386 & j0.146646 & j0.1245772 & j0.1266143 \\ j0.127806 & j0.1245772 & j0.1492063 & j0.1221942 \\ j0.114287 & j0.1266143 & j0.1221942 & j0.135713 \end{bmatrix}$$

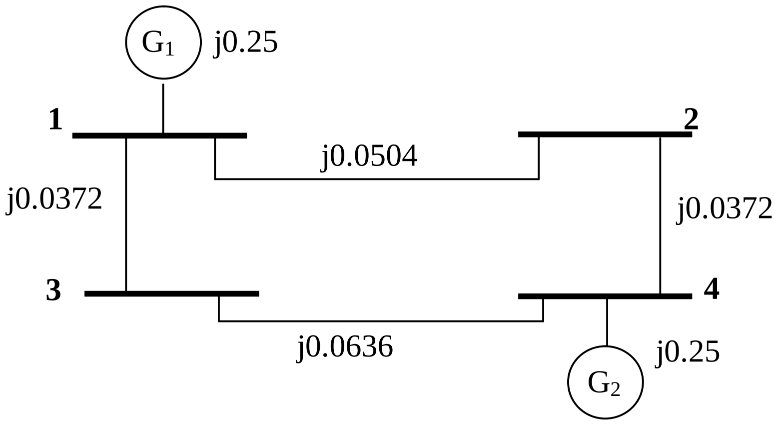

Figure 4

8- A 625 kV generator with $X_d''=0.2$ per unit is connected to a bus through a circuit breaker as shown in figure 5. Connected through the circuit breakers to the same bus are three synchronous motors rated 250hp, 2.4kV, 1 power factor, 90% efficiency with $X_d''=0.2$ per unit. The motors are operating at full load, unity power factor and rated voltage with the load equally divided among the machines:

a) Draw the impedance diagram with the impedance marked in per unit on a base of 625kVA, 2.4Kv.

b) Find the symmetrical short circuit current in amperes which must be interrupted by breakers A and B for a three phase fault at point P; simplify the calculations by neglecting the pre-fault current.

c) Repeat part (b) for a three phase fault at point Q.

d) Repeat part (b) for a three phase fault at point R.

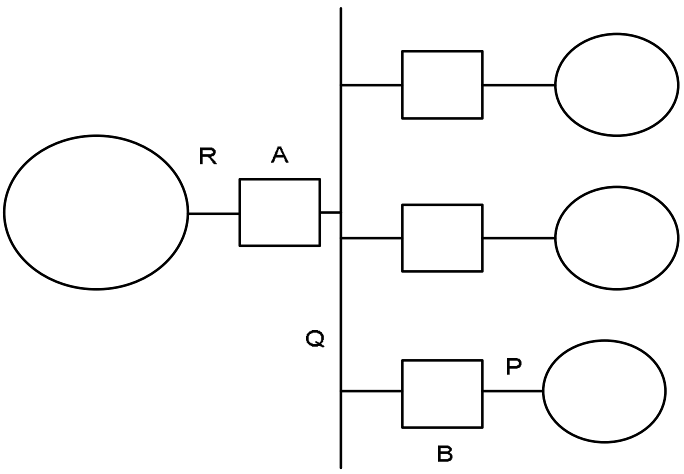

Figure 5