Arab Academy for Science and Technology

Electrical and Computer Control Department

Power System II (EE 441) sheet 2

1- If $V_{an}^{(1)} = 50\angle 0^{\circ}, V_{an}^{(2)} = 20\angle 90^{\circ}$ and $V_{an}^{(0)} = 10\angle 180^{\circ}$ V, determine analytically the voltages to neutral V_{an}, V_{bn}, V_{cn} and also show graphically the sum of the given symmetrical components which determine the line to neutral voltages.

2- When a generator has terminal *a* open and the other two terminals are connected to each other with a short circuit from this connection to ground, typical values for the symmetrical components of current in phase *a* are $I_a^{(1)} = 600\angle -90^{\circ}, I_a^{(2)} = 250\angle 90^{\circ}, I_a^{(0)} = 350\angle 90^{\circ}$ A. Find the current into the ground and the current in each phase for the generator.

3- Determine the symmetrical components of the three currents $I_a = 10\angle 0^{\circ}, I_b = 10\angle 230^{\circ}, I_c = 10\angle 130^{\circ}$

4- The currents flowing in the lines toward a balanced load connected in Δ are $I_a = 100\angle 0^{\circ}, I_b = 141.4\angle 225^{\circ}, I_c = 100\angle 90^{\circ}$. Find the symmetrical components of the given line currents and draw the phasor diagrams of the positive and negative sequence line and phase currents. What is I_{ab} in amperes?

5- The voltages at the terminals of a balanced load consisting of three 10Ω resistors connected in Y are $V_{ab} = 100\angle 0^{\circ}, V_{bc} = 80.8\angle -121.44^{\circ}, V_{ca} = 90\angle 130^{\circ}$ V. Assuming that there is no connection to the neutral of the load, find the line currents from the symmetrical components of the given line voltages.

6- A Y- connected synchronous generator has sequence reactances $X_0 = 0.09$, $X_1 = 0.22$, $X_2 = 0.36$, all in per unit. The neutral point of the machine is grounded through a reactance of 0.09 per unit. The machine is running on no-load with rated terminal voltage when it suffers an un balanced fault. The fault currents out of the machine are $I_a = 0, I_b = 3.75\angle 150^{o}, I_c = 3.75\angle 30^{o}$ all in per unit with respect to phase a line to neutral voltage. Determine:

a- The terminal voltages in each phase of the machine with respect to ground
b- The voltage of the neutral point of the machine with respect to ground
c- The nature (type) of the fault from the results of part (a)

7- Repeat problem 1 if the fault currents in per unit are $I_a = 0, I_b = -2.986\angle 0^{o}, I_c = 2.986\angle 0^{o}$.

8- Draw the negative and zero sequence impedance networks for the power system shown in figure 1. Mark the values of the reactances in per unit on a base of 50MVA, 13.8kV in the circuit of generator 1. Letter the networks to correspond to the single line diagram. The neutrals of generator 1 and 3 are connected to ground through current limiting reactors having a reactance of 5% each on the base of the machine to which it is connected. Each generator has negative and zero sequence reactances of 20 and 5% respectively on its own rating as base. The zero sequence reactance of the transmission line is 210Ω from B to C and 250 Ω from C to E.

Generator 1: 20MVA, 13.8kV, X_d'' =0.2 per unit

Generator 2: 30 MVA, 18 kV, X_d'' =0.2 per unit

Generator 3: 30 MVA, 20 kV, X_d'' =0.2 per unit

Transformer 1: 25 MVA, 220Y/13.8Δ kV, X=10%

Transformer 2: Single phase units each 10 MVA, 127/18 kV, X=10%

Transformer 3: 35 MVA, 220Y/22Y kV, X=10%

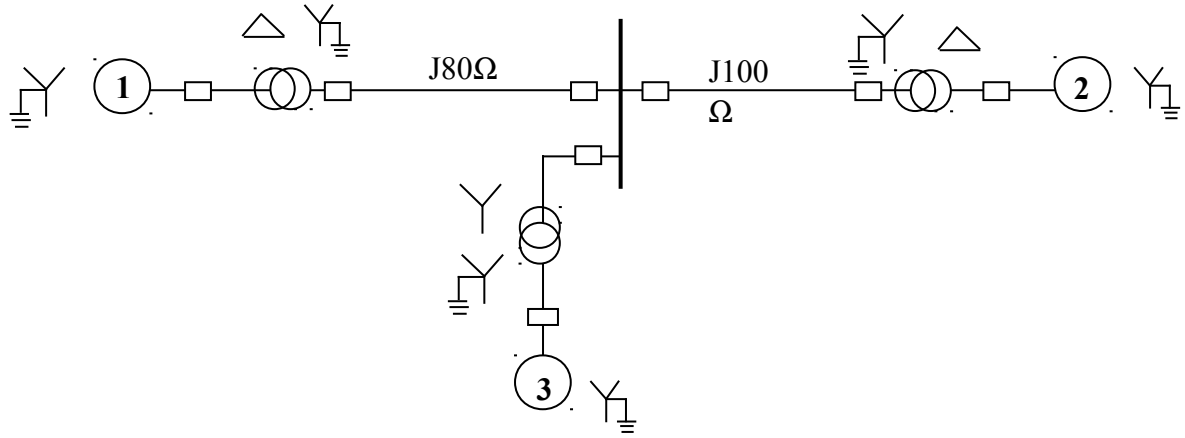

Figure 1

9- Draw the negative and zero sequence impedance networks for the power system shown in figure 2. Choose the base to be 50MVA, 138 kV in the 40 Ω transmission line and mark all reactances in per unit. The negative sequence reactance of each synchronous machine is equal to its subtransient reactance. The zero sequence reactance of each machine is 8% based on its own rating. The neutrals of the machines are connected to ground though current limiting reactors having a reactance of 5%, each on the base of the machine to which it is connected. Assume the zero sequence reactances of the transmission lines are 3 times the positive sequence reactances.

Generator 1: 20MVA, 18 kV, X_d'' =20%

Generator 2: 20 MVA, 18 kV, X_d'' =20%

Synch. motor 3: 30 MVA, 13.8 kV, X_d'' =20%

Transformers Y-Y: 20 MVA, 138Y/20Y kV, X=10%

Transformer Y-Δ: 15 MVA, 138/13.8 kV, X=10%

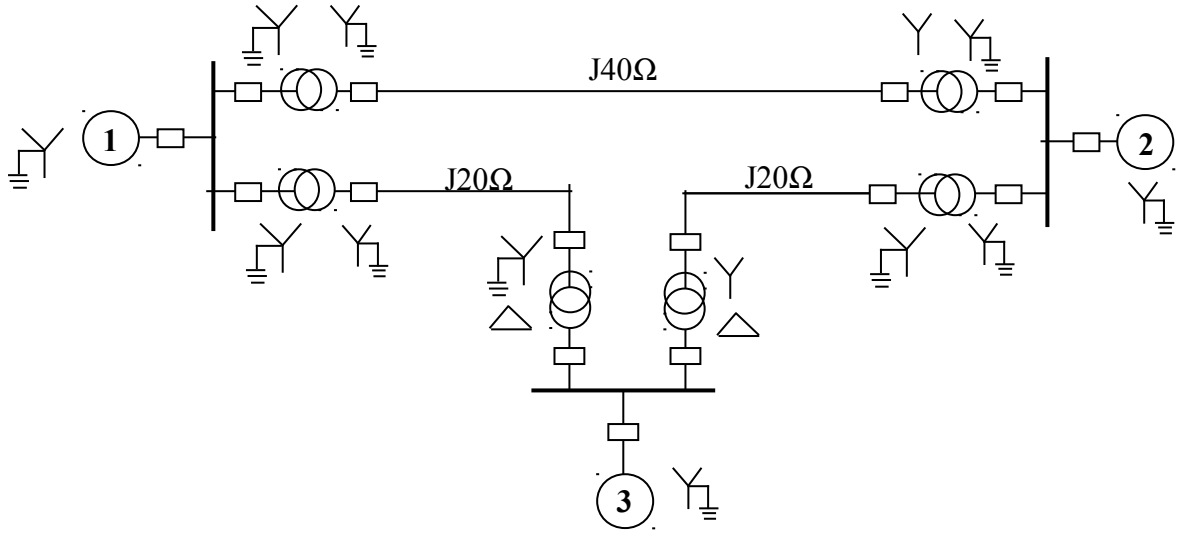

Figure 2