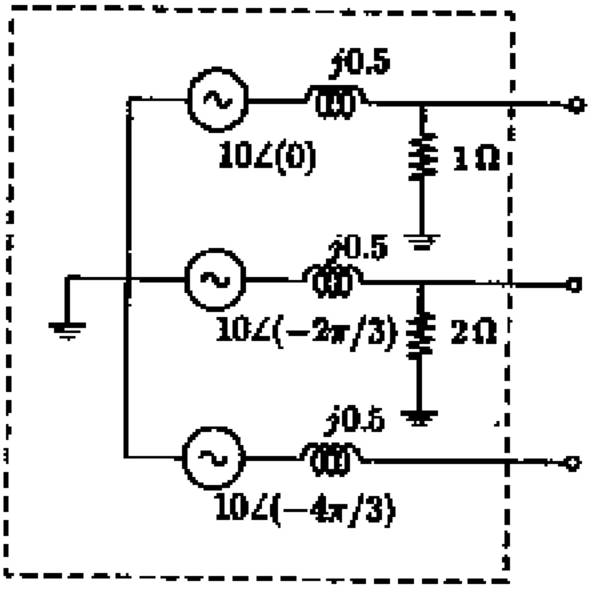
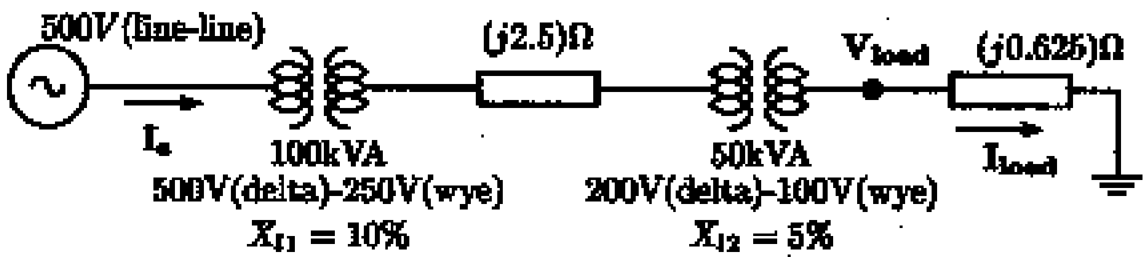
Circuit Analysis

1. Find the Thevenin's equivalent of the given circuit. (10%)



Per Unit

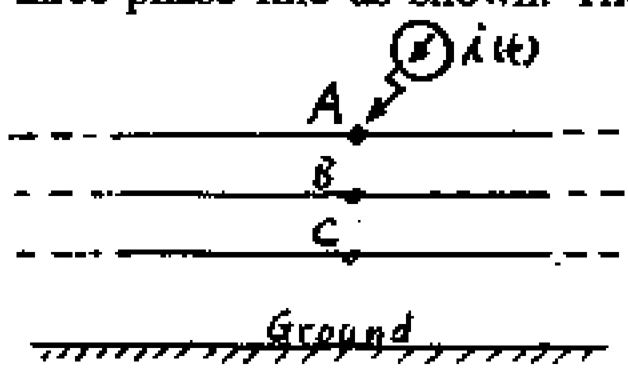
2. Refer to the one-line diagram of a fictitious power system below. Calculate the following based on the name-plate values of the transformers (reactances given in percent), line impedance (in Ω) and load impedance (in Ω): (1) load voltage V_{load}; (2) source current I_s. Assume the generator and load are both Y-connected. Note $\frac{1}{\sqrt{3}} = 0.577$. (15%)



Transient Analysis

3. A lightning current stroke to phase A of a three-phase line as shown. The line surge impedance matrix is

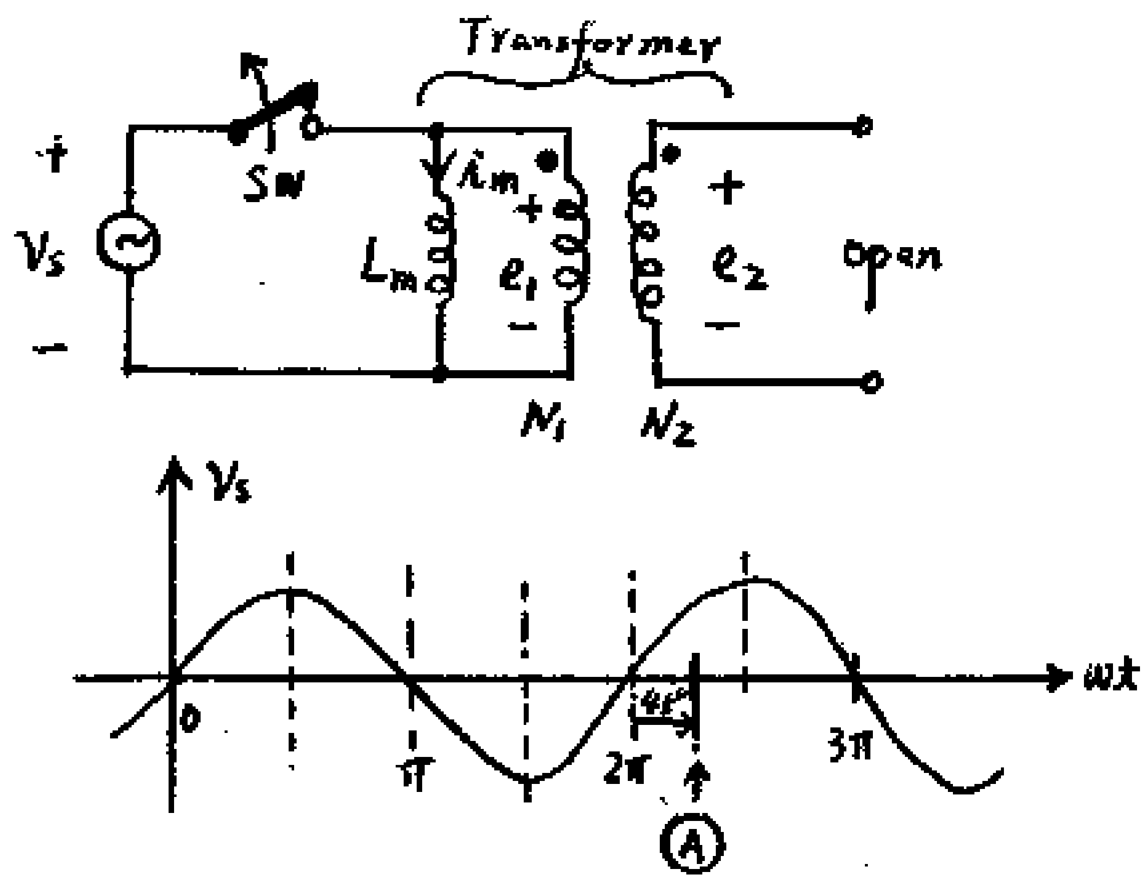
$$R = \begin{bmatrix} 500 & 50 & 25 \\ 50 & 500 & 50 \\ 25 & 50 & 500 \end{bmatrix} \Omega$$



(a) Find the voltage build-up at points A, B and C over a time span during which reflections have not yet come back from the remote ends of the line.

(b) Suppose that $\nu_B = k_1 \nu_A$ and $\nu_C = k_2 \nu_A$; k_1 and k_2 are proportional constants. Find k_1=?, k_2=? (15%)

4. The switch SW is originally closed steadily, and it is opened at the time instant denoted by (A). Sketch the following waveforms: e_1, i_m, and e_2. (10%)



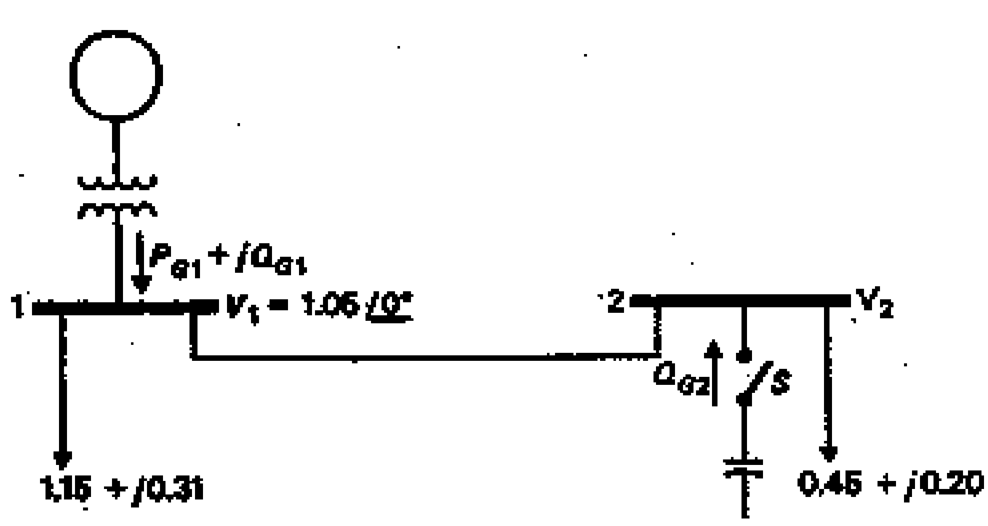
Power Flow

5. For the power system shown below, the system bus admittance is

$$Y_{bus} = \begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix}$$

where $y_{21}=1.9\angle\theta_1$ and $y_{22}=1.8\angle\theta_2$. Assume:

- The switched capacitor at bus 2 is out;
- The power bases selected are S_b=300MVA, V_b=230kV;
- The line reactance between buses 1 and 2 is 91Ω.



Answer the following questions:

(a) Estimate θ_1 and θ_2 by selecting one of the following combinations:

θ_1=99°, θ_2=-80°
θ_1=-99°, θ_2=80°
θ_1=9°, θ_2=-10°
θ_1=-9°, θ_2=10°

(b) Let $V_2^{(0)}$ denote the initial guess of bus 2 voltage. Which do you give among the following to $|V_2^{(0)}|$?

0.95 pu kV
1.00 pu kV
1.05 pu kV
Select one of them.

(c) Let $\delta^{(0)}$ denote the phasor angle for $V_2^{(0)}$. Write down your formula to estimate $\delta^{(0)}$ (You are not requested to actually calculate $\delta^{(0)}$).

(d) Having obtained $|V_2^{(0)}| \angle \delta^{(0)}$, write down the Gauss-Seidel iterative computation formula to calculate $V_2^{(1)} = |V_2^{(1)}| \angle \delta^{(1)}$ (Assume $\delta^{(0)}$=13.5°. Also, you are not requested to actually calculate $V_2^{(1)}$).

(e) Now we energize the capacitor at bus 2, and give an initial guess for V_2 at $V_2^{(0)} = 1.0\angle -10°$. Rewrite the Gauss-Seidel iterative computation formula to calculate $V_2^{(1)} = |V_2^{(1)}| \angle \delta^{(1)}$. (Note: In this case, you can not actually calculate $V_2^{(1)}$, because you have not estimated the reactive power injection into bus 2, i.e., you have not estimated $Q_2^{(0)} = Q_{G2}^{(0)} - 0.20$).

(f) After the energization of capacitor at bus 2, which can you observe in the system?

(1) Line loss decreases.

(2) Line charge increases.

(3) P_{G1} decreases.

(4) δ_2 decreases.

(5) None is correct.

Give you selections (You are allowed to give multiple selections. If any one selection is incorrect, Problem (f) will not be given any credit). (25%)

Fault Analysis

6. For the generator in Problem 1. Let E_a, E_b and E_c denote:

   $E_a=10\angle 0$

   $E_b=10\angle -2\pi/3$

   $E_c=10\angle -4\pi/3$

   Assume a direct ground fault occurs at the generator terminal of phase a. Can you compute the fault current by using sequence network? If you answer is positive, draw the sequence network; otherwise, give your explanation. (10%)

Protection

7. Answer yes or no, and give your brief explanation (give key phrases only, not more than 10 Chinese characters for each answer).

   (a) Stator voltage unbalance can cause stator overheating on the winding but not on the iron.

   (b) Generator's loss of excitation can cause overheating of stator winding and stator end core.

   (c) Assume fuse A is closer to the power source than fuse B. To coordinate these two fuses. The minimum clearing time (MinCT) of fuse A is longer than the Maximum melting time (MaxMT) of fuse B. (15%)