Power Systems Analysis,
11.10.2024,
Part I (30m)

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Questions:
2 points for this part
For every question there is only one correct answer. If you choose:

- The only correct answer; $\longrightarrow$ +0.2 points
- One of the three incorrect answers $\longrightarrow$ −0.06 points;
- None or multiple answers $\longrightarrow$ 0 points.

$\longleftarrow$ Insert your SCIPER number on the left and write your full name below. $\downarrow$

Surname and Name:

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Questions

1. If a DC source V_2 is connected to the secondary of an ideal transformer, in steady-state conditions the voltage on the primary will be:

   ☐ $V_1 = V_2(N_1/N_2)$
   ☐ $V_1 = V_2(N_2/N_1)$
   ☐ $V_1 = V_2(N_1/N_2)^2$
   ■ $V_1 = 0$.

2. The shunt capacitance of a line, in per unit of length represents:

   ☐ The magnetic coupling among the different conductors.
   ■ The electric coupling among the different conductors and the earth plane.
   ☐ The transverse power losses of the line due to the corona effect and insulation losses.
   ☐ The Joule-effect dissipative phenomenon along the line's conductive material.

3. Two students of Power Systems Analysis are debating on the choice of voltage bases for simplifying the circuit in Fig. 1. The two proposed choices are:

   (a) $V_{BUS\,1} = 10.0$ kV, $V_{BUS\,2} = 230$ kV, $V_{bU1} = 23$ kV, $V_{bU2} = 20.9$ kV

   (b) $V_{BUS\,1} = 956.5$ V, $V_{BUS\,2} = 22.0$ kV, $V_{bU1} = 2.2$ kV, $V_{bU2} = 2.0$ kV

   Which one is the preferred set of bases?

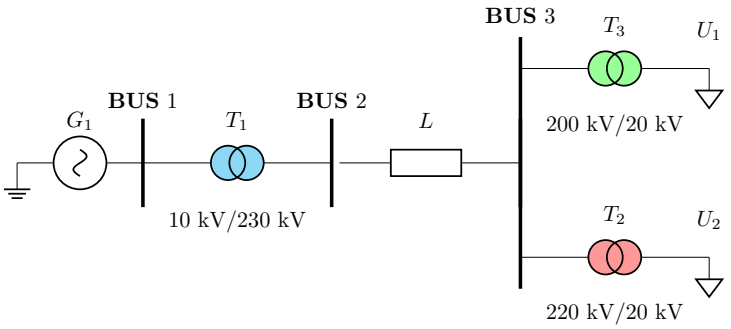

Figure 1: Equivalent single phase circuit

- ☐ Only option (a).
- ☐ Only option (b).
- ■ Both options (a) and (b).
- ☐ A preferred set of voltage base values does not exist because three transformers with different voltage ratings are connected on the same part of the grid.

4. The propagation constant of a line:

   - ☐ Is a real number.
   - ☐ Is a complex number that depends exclusively on the line resistance per unit of length.
   - ■ Depends on both the per-unit-length longitudinal impedance and the transverse admittance of the line.
   - ☐ Is higher for high-voltage overhead lines than for cables.

5. You have a transformer without a datasheet, and you need to determine the short-circuit impedance, z_{cc}. Here's what you can do:

   - ☐ Apply the nominal voltage to the low-voltage winding, short-circuit the high-voltage winding, and measure the resulting current in the low-voltage winding.
   - ☐ Apply the nominal voltage to the high-voltage winding, short-circuit the low-voltage winding, and measure the resulting current in the high-voltage winding.
   - ☐ Apply the nominal voltage to the high-voltage winding, short-circuit the low-voltage winding, and measure the resulting current in the low-voltage winding.
   - ■ None of the above.

6. The frequency measurement of the three-phase system generated by a synchronous generator initially operated disconnected from the grid, is depicted in Figure 2. The figure displays the frequency before and after the synchronization process with a large power grid operating at a constant frequency of 50 Hz. At precisely 14:14:13.400, the synchronization occurs, resulting in a constant speed of 1500 rpm for the synchronous generator. Which one of the following statement is **TRUE**?

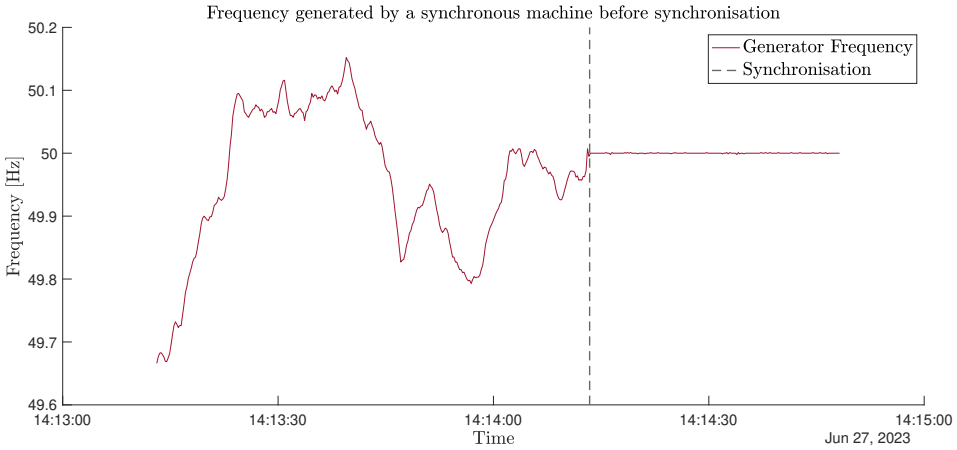

Figure 2: Frequency measured at the terminals of a synchronous machine before and after the synchronization with a larger power system with a constant frequency of 50 Hz.

- ☐ After the synchronization, to deliver active power to the grid, the excitation current has to be increased.
- ☐ The synchronous machine has ten pairs of poles (20 poles in total).
- ☐ Before the synchronization, the excitation current can be zero.
- ■ None of the above.

7. Consider a synchronous generator connected to a large power grid and in the operating condition shown in Fig. 3.V_A and E_i are the generator's terminal voltage and internal e.m.f., respectively, δ is the angle between them and θ as the angle between the synchronous generator's terminals voltage and current I_A. If you are asked to operate the synchronous machine so that it provides zero reactive power to the grid:

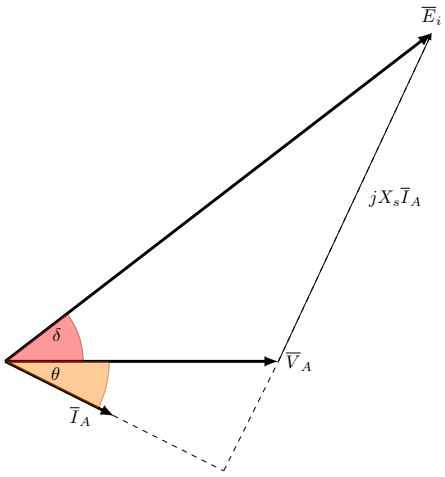

Figure 3: Phasor diagram for a synchronous machine in a certain operating condition.

- ☐ You have to increase the excitation current.
- ■ You have to decrease the excitation current.
- ☐ You have to increase the prime mover torque.
- ☐ You have to decrease the prime mover torque.

8. Consider the same synchronous machine of Question 7, with the machine first in the operating state *(a)*, visible in Fig. 3 and then with zero reactive power supply to the grid (state *(b)*). What happens to the magnitude of the current $\bar{I}_A$?

- ■ I_A in state *(b)* is lower than in state *(a)*.
- ☐ I_A in state *(b)* is higher than in state *(a)*.
- ☐ I_A in state *(b)* is the same as in state *(a)*.
- ☐ The value of I_A in state *(b)* depends on how X_s changed from the previous operating state *(a)*.

9. Consider a three-phase system where the center of the phase-to-ground voltages is connected to the earth via a zero impedance (ideal grounding). Which one of the following statements is **FALSE**?

- ☐ The homopolar (zero sequence) voltage must equal zero.
- ■ The homopolar (zero sequence) current must equal zero.
- ☐ The homopolar (zero sequence) current can equal zero.
- ☐ The homopolar (zero sequence) current can flow to the ground.

10. You are given the time-domain waveforms of voltage V and current I on the right in Fig. 4. From this, you draw the corresponding phasor plot on the left. Which of the following statements is **TRUE**?

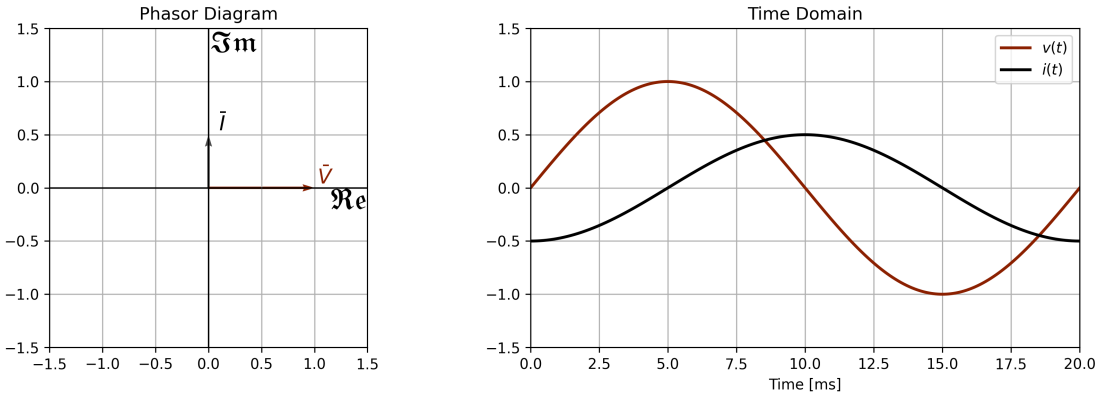

Figure 4: Time-domain waveforms (right) and phasor diagram (left) for voltage and current

- ■ The phasor diagram is incorrect.
- ☐ The instantaneous power $p(t)$ is always zero.
- ☐ The measurement is taken in the USA power grid.
- ☐ None of the above.