HOMEWORK NO.3

On Figure 1. you can see a power system in which there is only one consumer connected to node E who is powered by a high voltage network consisting of lines B-E, D-E, and B-D (their lengths are shown on the figure). There are two generators in the system connected to the transmission network via block transformers T_1 and T_2.

All the lines have the same parameters such as: r = 0,031 Ω/km, x = 0,327 Ω/km и b = 3,48 μS/km, whereas the maximum apparent power is S_{max} = 1200 MVA.

Transformers[1] T_1 and T_2 have the following nominal parameters: S_n = 400 MVA, U_{1n} = 400 kV, U_{2n} = 15,75 kV, u_k = 11%, ΔP_{Cu} = 600 kW. The voltage regulation step of the high voltage winding is 1,5 %, and the transformers operate with a ratio equal to 1 p.u. (the regulation switch is on position 0).

The data for the generators is given in Table 1.

The power of the consumer on Figure 1. that is equal to (400 + j250) MVA needs to be multiplied with the coefficient k which is different for every student and can be found in Table 2. Beside that, with the same coefficient you need to multiply the active power of the generator in node A. That means for ex. Student 1 will need to work with the following power of the consumer 0,5·(400 + j250) = (200 + j125) MVA and active power of 110 MW for the generator in node A and etc.

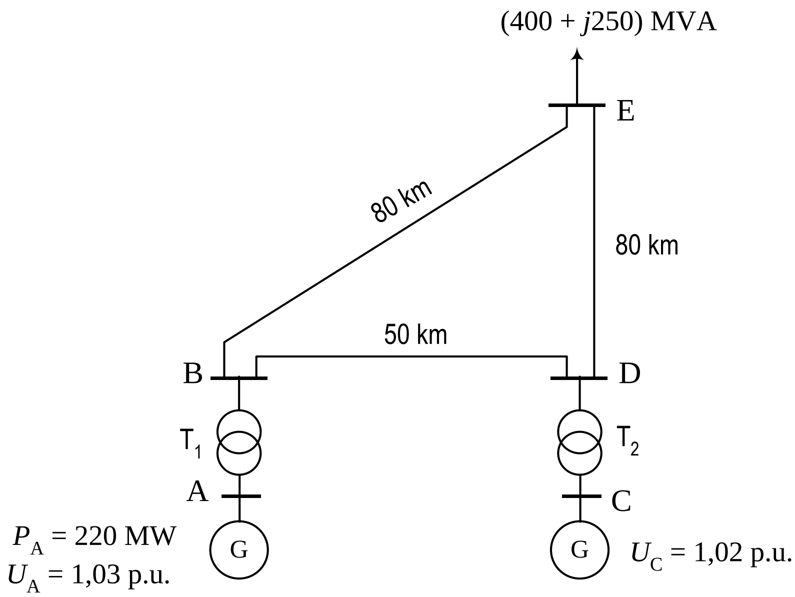

Figure 1. Single line diagram of the power system

Table 2. Data for the generators

Node	P_{min}(MW)	P_{max}(MW)	a (€/h)	b (€/MWh)	c (€/MW^{2}h)	Q_{min}(MW)	Q_{max}(MW)
A	0	1000	100	20	0,10	0	500
C	0	1000	100	15	0,12	0	500

[1] When entering the data of the transformers, always write as the second node the node in which the regulation switch is located, that node is the node with the higher nominal voltage.

Table 2. Values of the coefficient *k*

No.	Surname and Name	*k*
12	Николов Филип	1,25

Starting from the basic operating mode of the system, by applying the program NRPF.xlsm and using Excel to enter the data for the system, you need to solve the following problems (while considering that each problem is independent and the changes in the operating mode there are must not be taken into account in the other problems):

1. Calculate the voltage in the system and check if the voltage levels are too high or too low depending on the allowed range of change 0,95-1,05 p.u. Then, assume that the transformers can change their transmission ratio in the range of $\pm 10 \times 1{,}5\%$ and determine the position of the switches in both transformers so that the voltage in node E is approximately equal to 1 p.u.
2. Determine the reactive power of the capacitor bank that needs to be placed in node E so that the voltage in that node is equal to 1 p.u. Also determine the effect of this capacitor bank on the line load and the total active power losses in the system.
3. Another parallel line is added to the system to the D-E line which has the same parameters as that one. Determine the effect of the newly added line over the voltage in node E and the total active power losses.
4. Due to maintenance line D-E is disconnected from operation. In that case, is the operating mode of the system acceptable? By how much do the active power losses increase in that case?

It is necessary to prepare a report in which the results of the previously defined analyzes will be presented. The document should contain:

- Input data for the considered network;
- Information on what analysis is done and what scenarios are reviewed (for each section separately);
- Tables with the required results (voltage, branch loads, power losses, etc.);
- Comments on the obtained results.