2 PROJECT INFORMATION

Electricity is generated in bulk and transmitted to consumption areas via HV overhead lines. Therefore, the selection of transmission line and tower plays an important role in transmission system planning. Geometry of the conductor positions plays an important role in the calculation of electrical parameters of a transmission line. In practice, there are many types of transmission towers.

Figure 1: 735 kV transmission lines carried on V-guyed towers, 4-bundle (Quebec, Canada)

Figure 2: Double circuit 6-bundle 765 kV transmission line

Figure 3: 380 kV transmission tower in Turkey during construction

Figure 4: Zhoushan Island overhead line with the tallest power pylon in the world with 380 m. (500 kV 4-bundle)

As it can be seen in figures, spacers are used in order to prevent the contact of conductors in a bundle. Those spacers also have an important role in the calculation of electrical parameters of transmission lines. The number of conductors in a bundle and the distance between them may vary as it can be seen in Figure 5 and Figure 6.

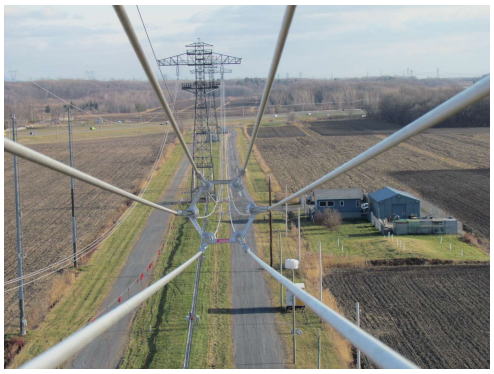

Figure 5: Spacer for a 6-bundle transmission line

Figure 6: Spacer for an 8-bundle transmission line, 1100 kV China

The distance between phases, circuits and bundles may vary. For example, in Figure 2 you can see a double circuit line, where the electrical parameters are strongly related to the distances between circuits.

There are many other specifications in transmission line and transmission tower design. However, the most important properties in terms of power system analysis are explained above. Some extra information is given below:

- The purpose of colorful spheres or cone shaped indicators in transmission lines are to inform helicopter pilots about transmission lines.
- The purpose of the shape of insulators is to make the surface flashover path longer.
- The purpose of ground wires is to protect the phase conductors from lightning strokes. Also, they provide a path for return currents.
- The higher the system voltage, the longer the insulator length.

As you expect, there are more parameters that can affect the design of a tower; however, those are out of scope of this course. In this project, you will need only basic parameters as input that are listed here:

- number of circuits
- number of bundle conductors, where bundles form a regular polygon
- bundle distance, which is the length of the edges of the polygon that a bundles forms (in m)
- length of the line (in km)
- name of the ACSR conductor
- location of the phases with respect to the origin
- a library of ACSR conductors and their parameters

Note that the library parameters will be given in Imperial Unit System and you should convert those values to SI units. Also, note that the system is **50 Hz**. With these raw input parameters, we expect students write a function to calculate the electrical parameters of a line in per unit. To compute these parameters, Geometric Mean Distance (GMD), Geometric Mean Radius (GMR) of the line are found first. You will be introduced with these concepts in the following weeks of the course. You are not required to know these information in the first phase of the project.

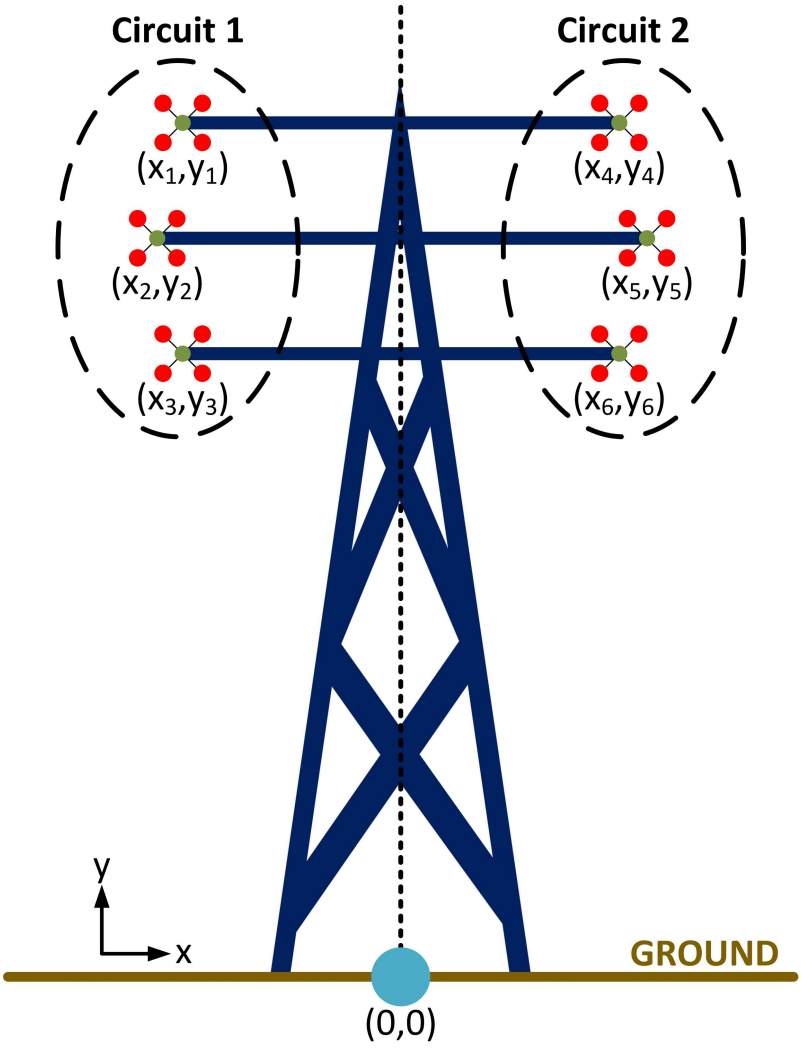

Figure 7: Definition of phase locations in input file.

In your input file you will be given x and y coordinates of bundle centre for each phase, where distances are given in *meters* with respect to origin. The definition of these x and y coordinates are described in Figure 7, i.e. position of dark green circles. In Figure 7 red circles are representing the conductors and dark green circles are representing the centre of each bundle.

3 PROJECT WORK

In this project you will be given a random transmission tower's specifications in a text file. Also, you will be provided with a library of ACSR conductors. In Phase 1, you are supposed to find a tool to preprocess the raw input data given in text format into a useful format for Phase 2 applications. In other words, you will create a function file that reads formatted data from text in MATLAB environment. In Phase 2, depending on these data your code should calculate the resistance (R), reactance (X) and susceptance (B) of the overhead line in *per unit* quantities.

These information will be valid for the transmission line to be modeled:

- You will be given only 3-phase systems (no single-phase systems)
- All phases consist of the same bundle orientation and same type of conductors
- Lines are transposed. The transposition rule is as follows.

Transposition cycle section	**Position 1**	**Position 2**	**Position 3**
1	Phase A	Phase B	Phase C
2	Phase C	Phase A	Phase B
3	Phase B	Phase C	Phase A

- If double circuits are used, they will have the same conductor types and length.

3.1 Phase 1

Tasks:

- Create a MATLAB function that reads the raw input data, which are listed in the previous section, given in the text file.
- The code must find the conductor name that is given in the input text file from the library and extract the necessary information about the conductor type from there, namely outside diameter, AC resistance at 20°C, and GMR of the conductor.
- Your function must give the outputs in SI Units, i.e. all lengths in meters. So, make the necessary unit conversions.
- Your function must take the input file and library paths in string format as the inputs of the function.

Evaluation:

- You must parse all the raw input data correctly and in correct format (string for the conductor name, double for other parameters).
- You must submit your function in this format. Note that the order of output variables is important (-10 Points for wrong function format):

$$[S_{base}, V_{base}, N_{circuit}, N_{bundle}, d_{bundle}, length,$$
$$conductor\_name, outside\_diameter, R_{AC}, GMR_{conductor}] = e123456\_p1(text\_path, library\_path)$$

- Upload m-file of your code to ODTUCLASS directly, first.
- Then, publish and upload the PDF format of your function on ODTUCLASS as Turnitin assignment. You may upload your m-files multiple times; however, the final m-file and PDF must be the same! Do not change your code after your Turnitin upload. Please beware that you have only one chance to submit the Turnitin assignment. (-20 points will be deducted from the total grade each time you request a re-submission.)

3.2 Phase 2

In this part, you are expected to submit a MATLAB function and a report. Your code must execute all the tasks in Phase 1, so refine your code.

Tasks:

- Your MATLAB function should calculate the electrical parameters of the line, i.e., series resistance & reactance (Ω), and shunt susceptance ($\mho$). (Include the effect of earth on shunt capacitance calculations.)
- Then, you must calculate these quantities in per unit using the base values given in the raw input text file.
- Write a maximum 5-page report on your observations. The report should not include explanation of your code rather it should include the followings:
  - The employed method, why and how you used it.
  - Any method/assumption/etc. you used to improve accuracy performance.
  - Test results.
  - Your observations on how changing the inputs in the text file affects the line parameters.

Evaluation:

- You must submit your function in this format where the data type of the output variables is double (-10 Points for wrong function format):

$$[R_{pu}, X_{pu}, B_{pu}] = e123456\_p2(text\_path, library\_path)$$

- Upload m-file of your code to ODTUCLASS.
- Then, publish and upload the PDF format of your function on ODTUCLASS as Turnitin assignment.
- Upload your report on ODTUCLASS as Turnitin assignment.
- Do not change your code after your Turnitin upload. You may upload your m-files multiple times; however, the final m-file and PDF must be the same. Please beware that you have only one chance to submit the Turnitin assignments. (-20 points will be deducted from the total grade each time you request a re-submission.)