

Shahjalal University of Science and Technology (SUST)

Department of Electrical and Electronic
Engineering (EEE)

Experiment No: 01

Experiment Name: To get familiar with Power World
-17 Simulator

Course Title: Power System –I Lab
Course Code: EEE 326

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Objective: To able to use the PowerWorld Simulator Version 17 tutorial to solve real-life electric power grid problems


Materials:

- PowerWorld Version 17 Simulator. The educational version is available as a free download at <http://www.powerworld.com/downloads/demosoftware.asp>
- Handout — PowerWorld Version 17 Simulator tutorial.

Time: 3 hours. Students have to download or take the Simulator from the class teacher and install it to their home computer after this class.

Assessment: Successful construction of the power grid.

PowerWorld Simulator v17 Software —

1. Click on the PowerWorld Simulator icon  to start the Simulator.
2. We are going to build a simple example of an electric power distribution grid, and let's just call it a grid. Also, the software refers to grids as **cases**.
3. PowerWorld v17 uses dropdown lists, which everyone is familiar with, however, because of the large number of features, the software also uses what are called “**ribbons**”. These ribbons take a little getting used to.
4. To create a new case —
 - Select **New Case** from the PowerWorld Icon —

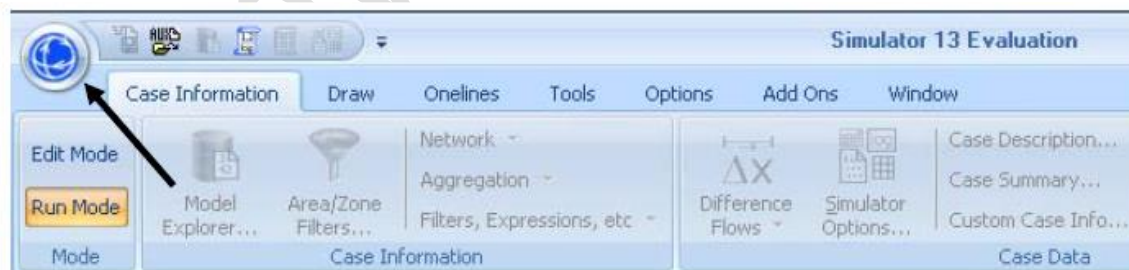


Fig: 1: PowerWorld Icon.

- The dropdown list
- The screen background will turn white.



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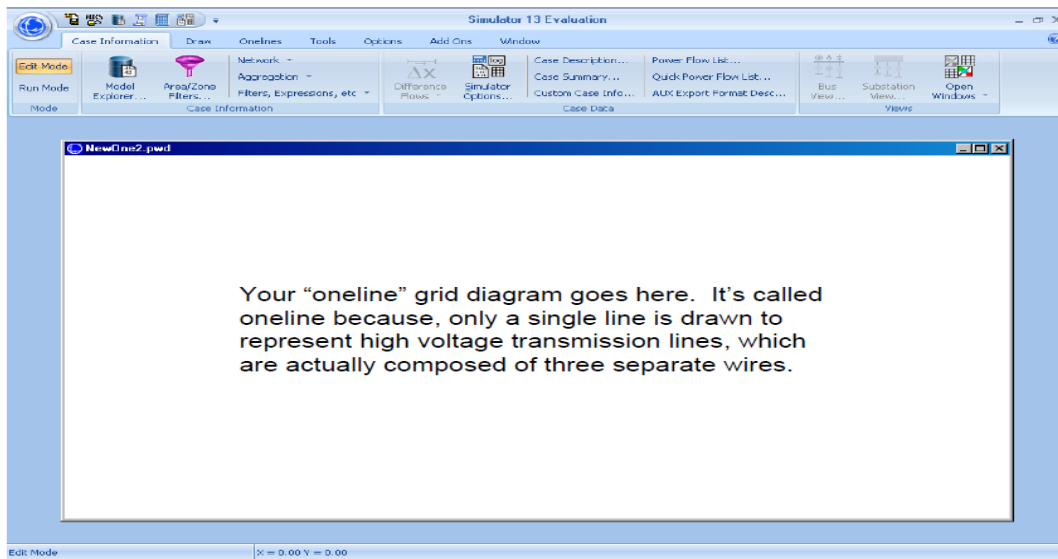


Fig. 2: PowerWorld Work Area.

5. Inserting a bus.

- Click on the Draw ribbon tab and find the Individual Insert ribbon group and the Network dropdown menu.

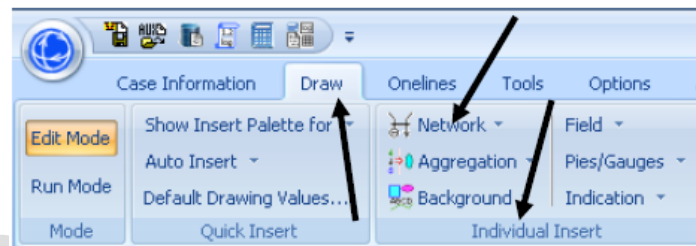


Fig. 3: Draw, Individual Insert, and Network Ribbons and Dropdown List

- Select **Network > Bus**.
- Left-click on the background where you want to place the bus. Let's go for upper-left.
- When you left-click, the Bus Option Dialog appears.

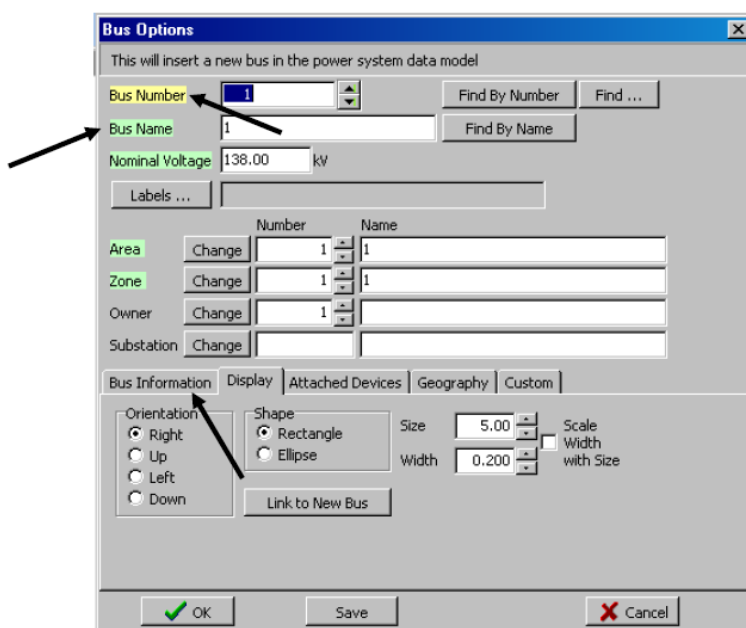


Fig. 4: Bus Options.

- Each bus needs its own number; leave this bus at (1) in the *Bus Number* field.
- The *Bus Name* Field is where you can give Bus-1 a unique name. For this example, I'm going to be clever — name it “One”.
- Don't change any of the other values in the Bus Option Dialog.
- Click on the Bus Information Tab and make sure that there is a check in the *System Slack Bus* field. Creating a Slack Bus ensures there is enough power for the system load — “it picks up the slack”. We'll need just one of these slack bus for the entire power grid.



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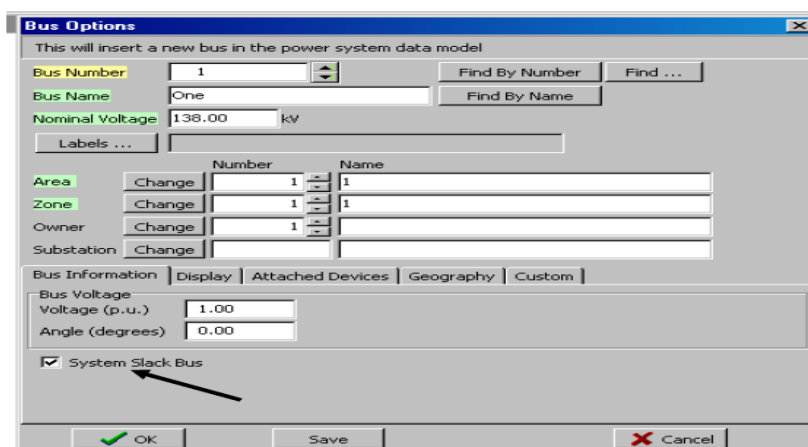


Fig. 5: Slack Bus.

- Click **OK** and you have something like this —

6. Inserting a generator. The bus you created needs some company.

- Select **Network > Generator** from the Individual Insert ribbon on the Draw ribbon tab.
- Left-click anywhere on bus (1), which you have just placed on the grid.
- When you left-click, the Generator Option Dialog appears.

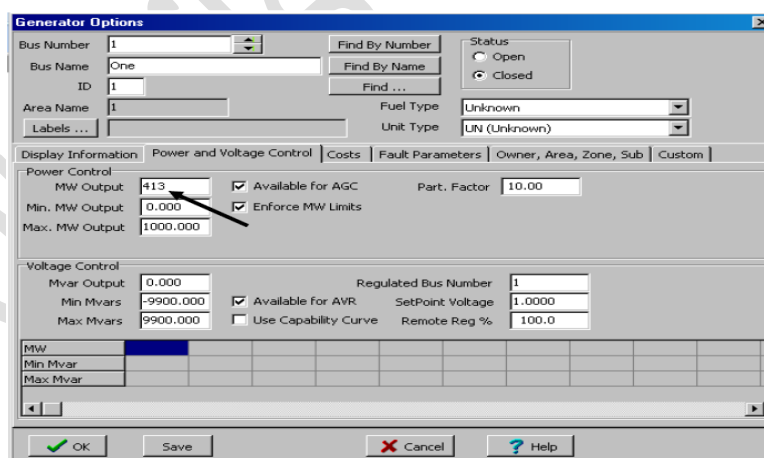


Fig. 6: Generator Option Dialog



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- Anytime you want to insert a generator, a *MW* (megawatt) *Output* must be entered so enter **413** in the *MW Output* field. Leave the rest of the default settings.
- Click on the *Display Information* Tab. In the *Orientation* field, place the generator on the bus — right, up, left, or down. Select down. The *Anchored* checkbox “locks” the generator to the bus. Be sure it’s checked. Don’t change any other settings.

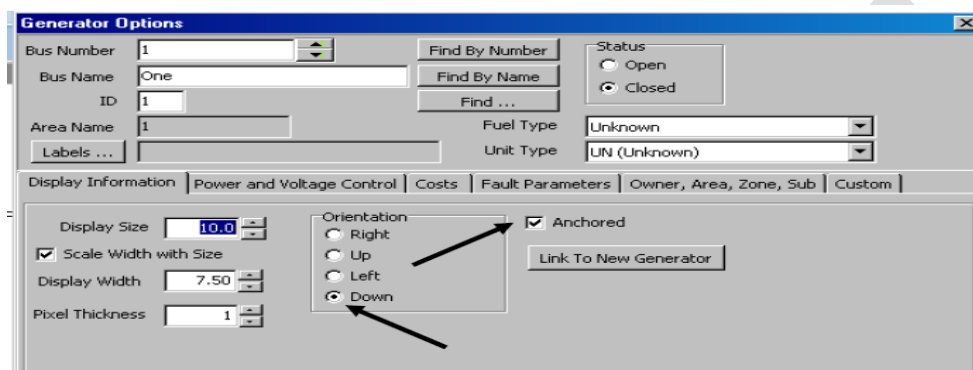


Fig. 7: Generator Orientation and Anchor to Bus.

- Click **OK**. Your image should resemble the following —

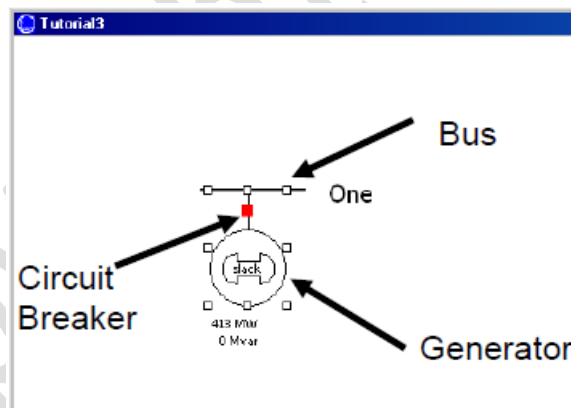


Fig. 8: Single Bus and Generator.

- If you need to make a correction, easiest way is to right click on the generator, bus, etc. When the drop down box appears, click on the corresponding *Information Dialog* and make your correction in the associated Options Dialog.



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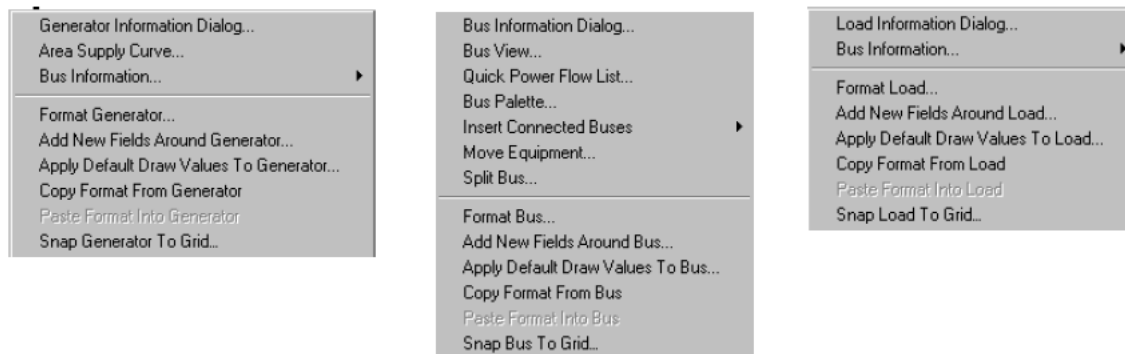


Fig. 9: Generator, Bus, and Load Information Dialog.

7. Entering a second bus.

Since our goal is to create a min-power grid, we're going to need more stuff.

- Follow the same steps used to create the first bus, but let's place this bus in the upper-right of the diagram.
- When the Bus Option Dialog comes up, leave the bus number at 2 and enter **"Two"** in the *Bus Name* field.
- We're going to place a **200 MW 100 Mvar** load on bus 2. To do this, click on the *Attached Devices* tab and under the *Load Summary Information* heading enter **"200"** in the *Base MW* field and **"100"** in the *Base Mvar* field.

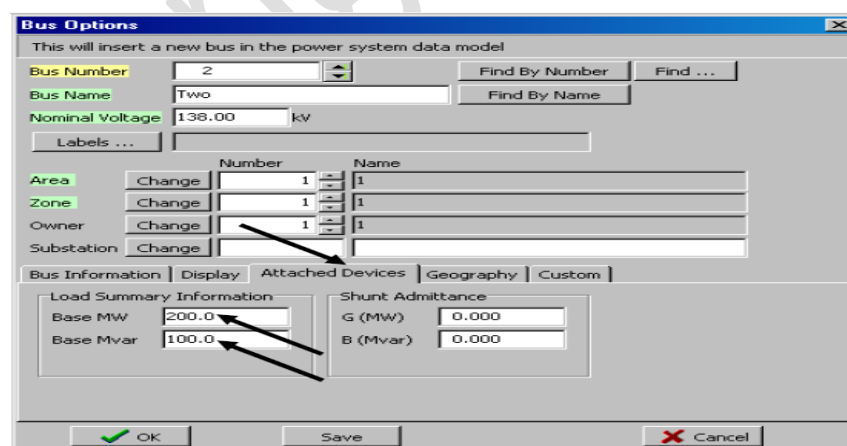


Fig. 10: Attached Devices.



- Click on the Bus Information Tab and **make sure that the System Slack Bus** field is **NOT CHECKED**.
- Leave all the other values as is and click **OK**.
- If you're wondering where's the load on the diagram, you haven't done anything wrong — at least not yet.
- To draw the load, select Network > Load from the Individual Insert ribbon group on the Draw ribbon tab.
- Left-click in the center of the second bus and the Load Options Dialog will open, confirming the load values.
- Select **Up** in the *Orientation* field under the *Load Information* tab.
- Verify that the *Anchored* box is checked.
- Click **OK**.

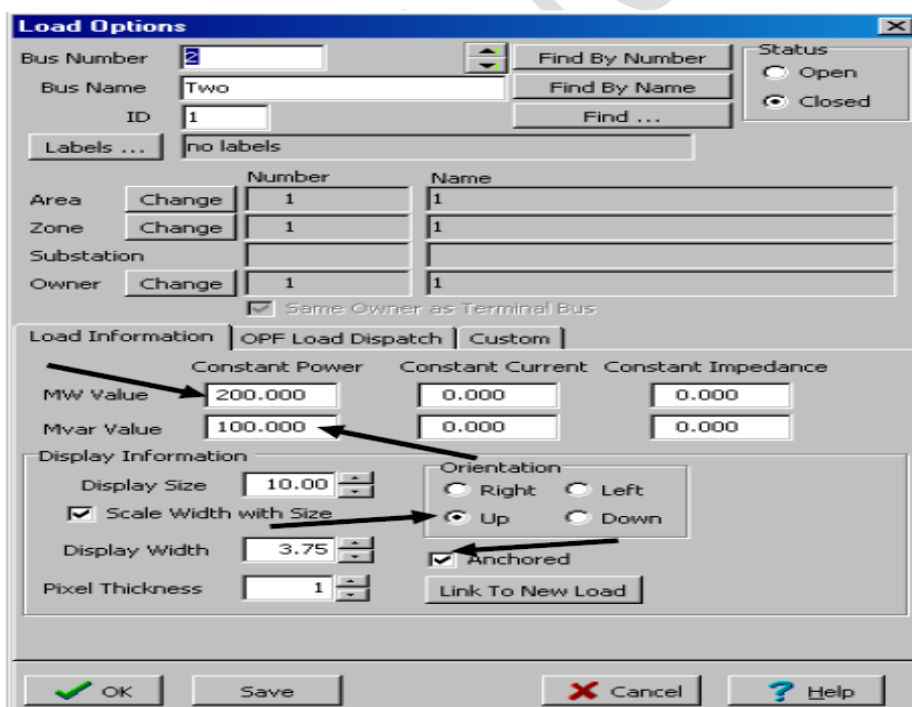


Fig. 11: Load Dialog Box



8. Inserting Transmission Lines.

We need to start connecting the two buses.

- Select **Network > Transmission Line** from the Individual Insert ribbon group on the Draw ribbon tab.
- Left-click at the point where you want to start, in this case the left side of bus (1).
- Transmission lines are drawn as a series of line segments. Without holding down the mouse button, drag the mouse up from bus (1).
- Terminate the transmission line segment, by clicking the left mouse button. Each time you click the mouse to terminate a line segment, a new **vertex** is created. To draw the next line segment, move the mouse to the right to the desired location of the next vertex, without holding down the mouse button.
- To terminate the final line segment and conclude drawing the line, double click the left mouse button on bus (2). The Transmission Line/Transformer Dialog appears. Verify that **1** appears in the *From Bus Number* field and a **2** appears in the *to Bus Number* field.
- The *Series Resistance*, *Series Reactance*, and *Shunt Charging* are used to enter the information associated with the line.
- Enter **0.02** in the *Resistance* field.
- Enter **0.08** in the *Reactance* field and **0.1** in the *Shunt Charging* field.
- The *Limit (MVA)* fields contain the MVA ratings for the line: enter a value of **1000** in the *Limit A (MVA)* field.

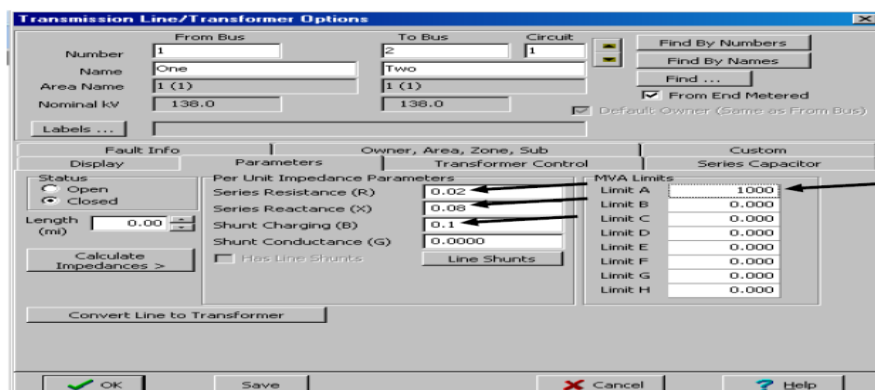
Fig. 12: Transmission Line Values.



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- Click **OK**. Your diagram should now look like the following —

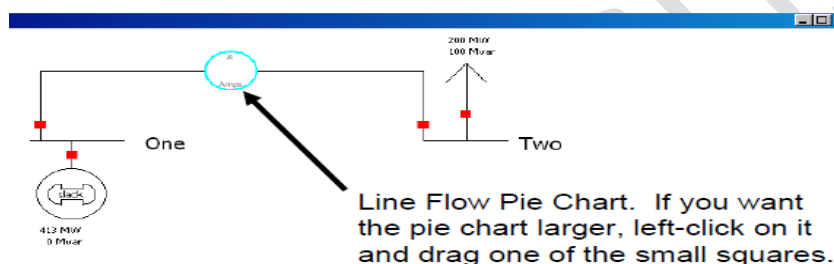


Fig. 13: Diagram with a Transmission Line.

10. Inserting Circuit Breakers.

The Simulator automatically inserts circuit breakers —

- However, if you need to insert an additional circuit breaker, click somewhere on the line that you want the circuit breaker.
- Select **Indication > Circuit Breaker** from the Individual Insert ribbon group on the Draw ribbon tab.
- Click on the line on second time, which will cause the Circuit Breaker Options Dialog to appear.

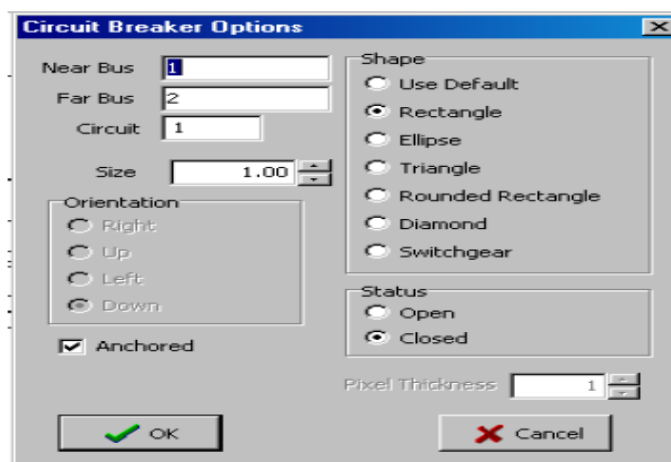


Fig. 14: Circuit Breaker Dialog Box.

11. Inserting a Transformer.

- To insert a transformer, you need to insert an additional bus at a different voltage level.
- Insert the new bus near the bottom of the diagram, named **Three**, and enter **69 KV** for its nominal voltage. Again, click on the Bus Information Tab and **make sure that the System Slack Bus field is NOT CHECKED.**
- Insert a transformer between buses (2) and (3) by going to **Network > Transformer** from the Individual Insert ribbon group on the Draw ribbon tab.
- Click on bus (2), and then draw a vertical line to bus (3) as you did for a transmission line. The Transmission Line/Transformer Dialog automatically appears as before.
- On the **Parameters** tab, enter **0.02** for *Series Resistance*.
- Enter **0.08** for *Series Reactance*.
- Enter **0.1** for *Shunt Charging*.
- Enter **1000** for *Limit A (MVA)*.



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Transmission Line/Transformer Options

From Bus: 2 To Bus: 3 Circuit: 1

Number: 2 Name: Two Area Name: 1 (1) Nominal kV: 138.0

To Bus: 3 Name: Three Area Name: 1 (1) Nominal kV: 69.0

Find By Numbers Find By Names Find ...

☒ From End Metered ☒ Default Owner (Same as From Bus)

Labels ...

Display Parameters Transformer Control Series Capacitor

Status: ☐ Open ☒ Closed

Length (mi): 0.00

Calculate Impedances >

Convert Transformer to Line

Per Unit Impedance Parameters

| | |
|-------------------------|----------|
| Series Resistance (R) | 0.02 |
| Series Reactance (X) | 0.08 |
| Shunt Charging (B) | 0.1 |
| Shunt Conductance (G) | 0.0000 |
| Magnetizing Conductance | 0.000000 |
| Magnetizing Susceptance | 0.000000 |

☐ Has Line Shunts Line Shunts

MVA Limits

| | |
|---------|-------|
| Limit A | 1000 |
| Limit B | 0.000 |
| Limit C | 0.000 |
| Limit D | 0.000 |
| Limit E | 0.000 |
| Limit F | 0.000 |
| Limit G | 0.000 |
| Limit H | 0.000 |

OK Save Cancel Help

Fig. 15: Transformer Parameters.

- Click **OK** and you should have the following or close to it —

12. Repeat the above *Insert a Transformer* procedure to add a transformer between bus (1) and bus (3).

13. Add a 400 MW, 200 Mvar load to bus (3).

- Right-click on bus (3) and select **Bus Information Dialog**.



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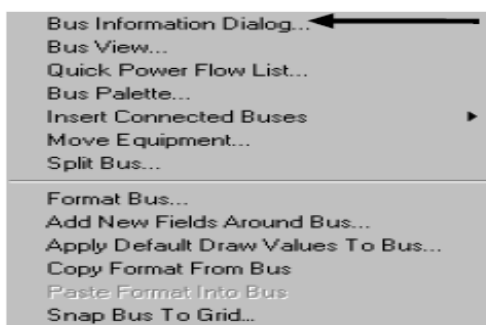


Fig. 16: Bus Information Dialog.

- Select the **Attached Devices**.
- Click **Add or Edit Bus Load**.

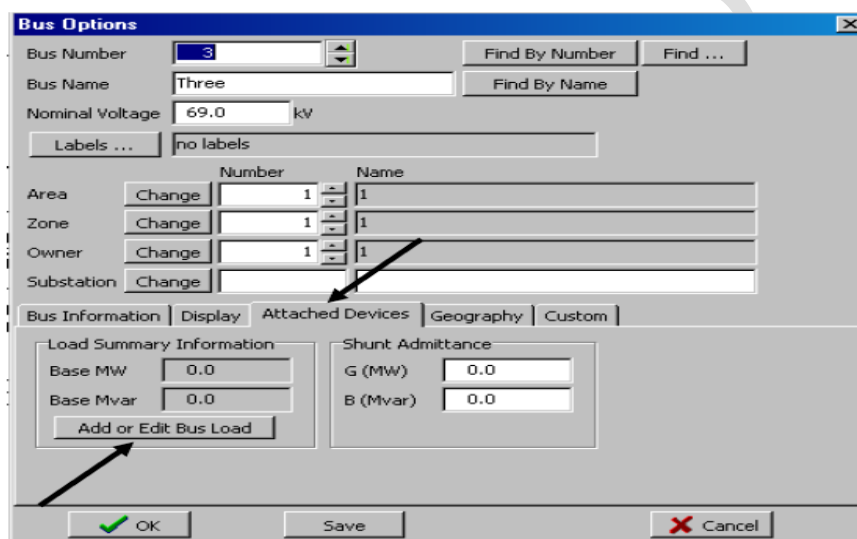


Fig. 17: Bus Options.

- Under *Constant Power* enter **400** in the *MW Value* field. Enter **200** in the *Mvar Value* field.



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Fig. 18: Add or Edit Bus Load.

- Click **OK**.
- Just like in Section (7), the load on Bus (3) isn't visible. If you need to, go back to that section and reread, but there is another way — **if values (a record) already exist for that particular load.**
- Select **Auto Insert > Loads ...** from the Quick Insert ribbon on the Draw ribbon tab.
- Finally, attach a 300 MW generator to bus (3).
- Select **Network > Generator** form the Individual Insert ribbon group on the Draw ribbon tab.
- Left-click on bus (3). The Generator Option Dialog opens.
- Select the *Power and Voltage Control* tab. Enter “**300**” in the *MW Output* field.
- Click **OK**. Your diagram should now resemble the following —

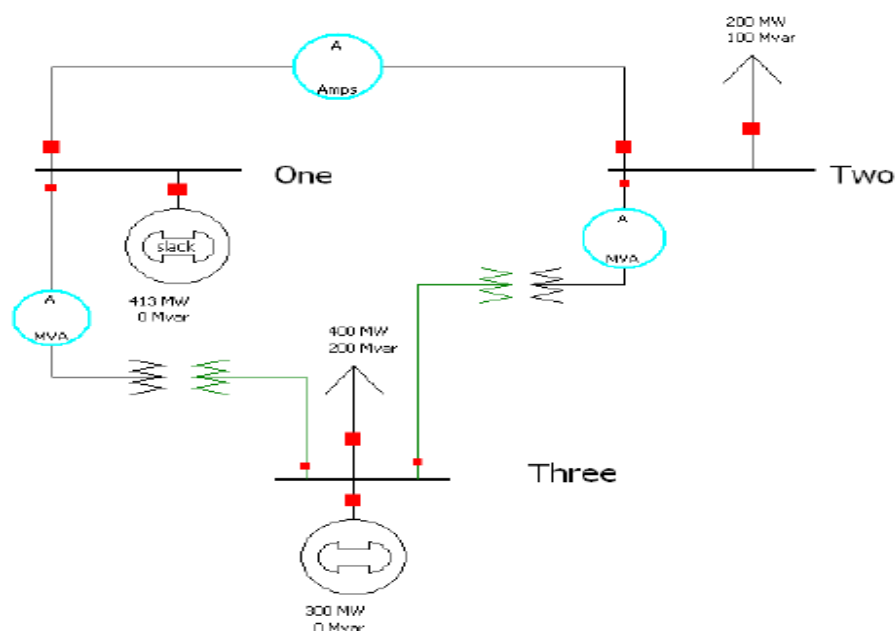


Fig. 19: Completed Power Grid.

14. Inserting Text and Data Fields.

We can put general text and text display quantities corresponding to individual objects — buses, generators, transformers, etc.

- For general text, select **Background > Text** from the Individual Insert ribbon on the Draw ribbon tab.

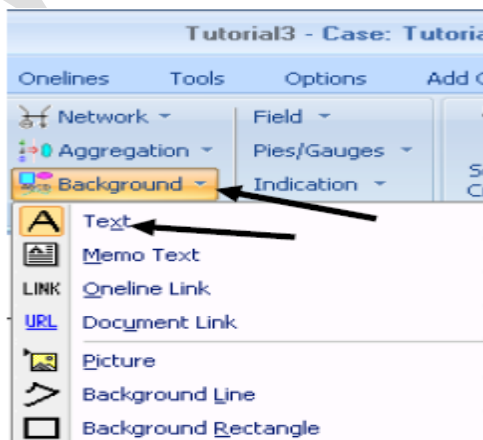


Fig. 20: General Text.



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- Left-click on the diagram in the desired text location to bring up the *Text Object Dialog*.
- Type some sort of title — “First Case”

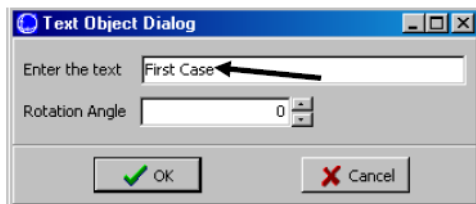


Fig. 21: Text Object Dialog

- Click **OK**.
- Like most text, the title can be formatted. Be sure the title is selected and then select **F** from the Formatting ribbon group on the Draw ribbon tab. This displays the Font Tab of the Format Selection Dialog.

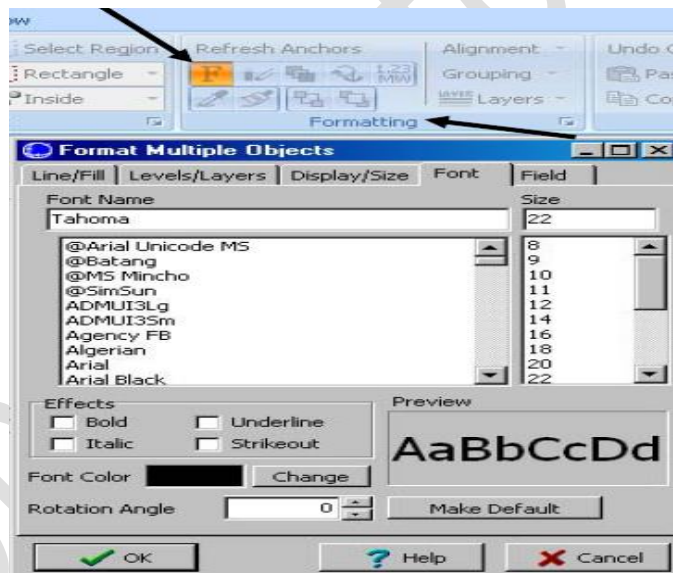


Fig. 22: Formatting Text.

- We also want to add text that will display quantities that may vary with the operation of the power grid, such as power and voltage.



- We want to add a Bus Voltage Magnitude field to each bus and additional fields showing the power flow on the transmission line and the transformers. These fields can be formatted just like the text fields by using the Format menu.
- To add additional fields to a particular bus, right-click on the bus, in this case bus (1) to bring up the bus' local menu.
- Select *Add New Fields Around Bus...* from the local menu.

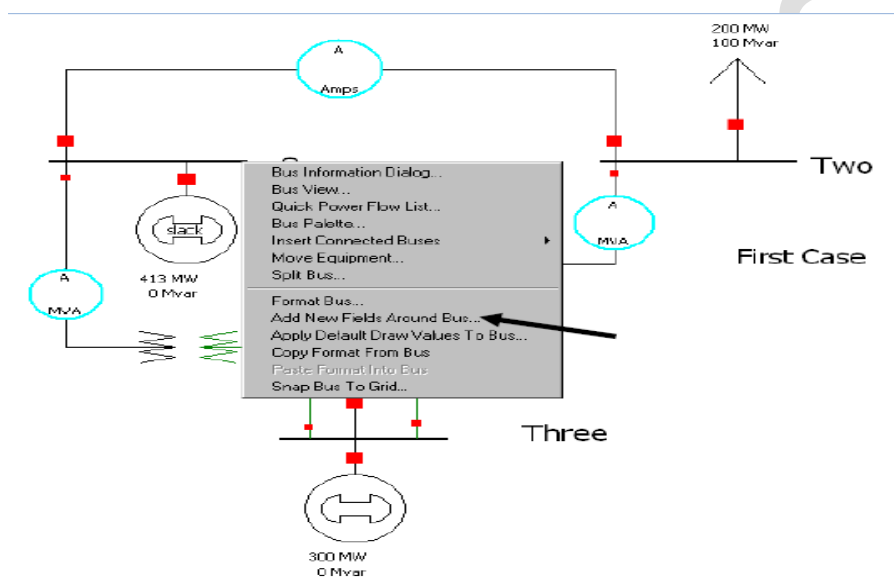


Fig. 23: Adding New Fields Around a Bus.

- This Opens the Insert Bus Fields Dialog.

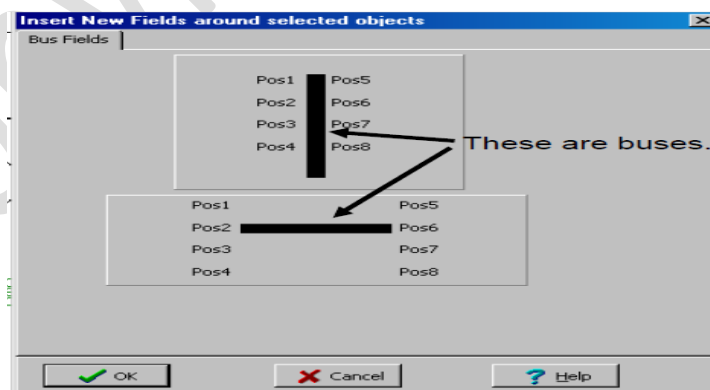


Fig. 24: Text Position.



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- Select the position where you would like to add the new field.
- This automatically opens the Bus Fields Options dialog; select the field **Bus Voltage** to add in the selected position.

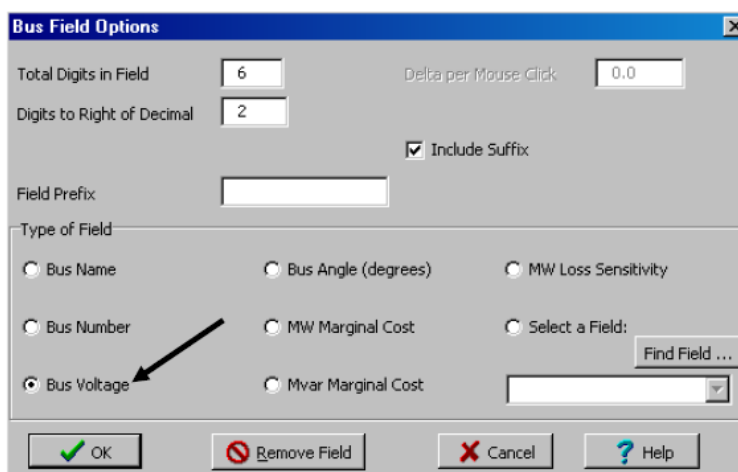


Fig. 25: Bus Voltage.

- Click **OK**.
- The quantity “**Voltage**” and position are displayed in the Insert New Fields dialog.

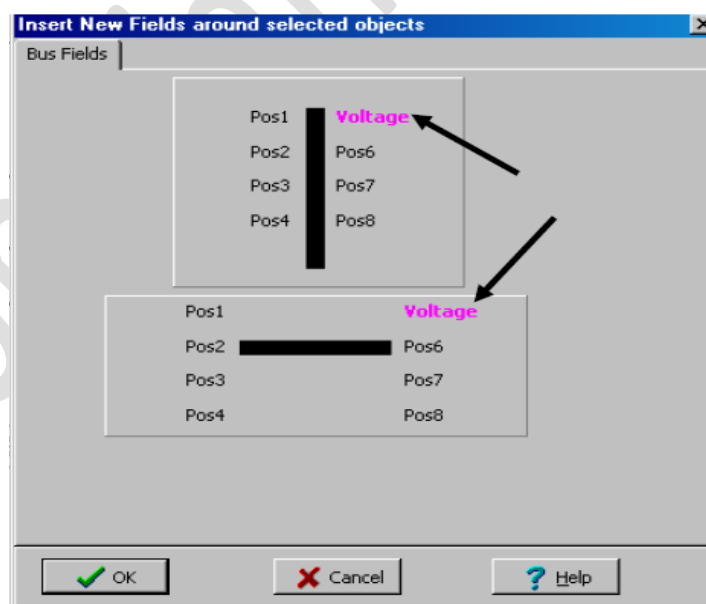


Fig. 26: Inserting New Fields.



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- Click **OK**.
- Repeat this procedure for the other two buses.
- next, we will insert text fields showing the power flow at each end of the transmission line. Select **Field > Transmission Line Field** from the Individual Insert ribbon groups on the Draw ribbon tab.

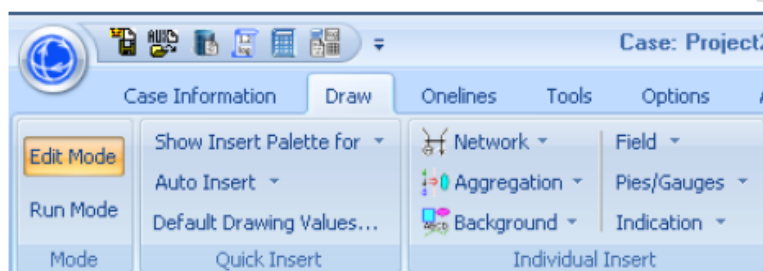


Fig. 27: Individual Insert – Network

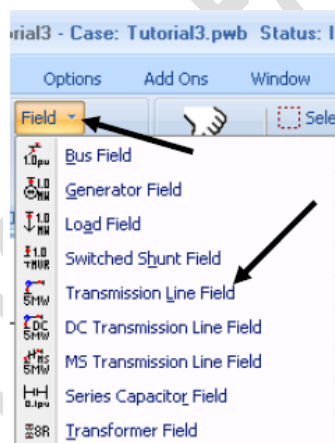


Fig. 28: Transmission Line Field

- Left-click near bus (1) and the transmission line between buses (1) and (2) in the location you want the power flow text to appear. The *Line Field Options* dialog opens automatically.
- The *Near Bus* and *Far Bus* fields should show **1** and **2**. If not, make the change.
- Select **MW Flow**.



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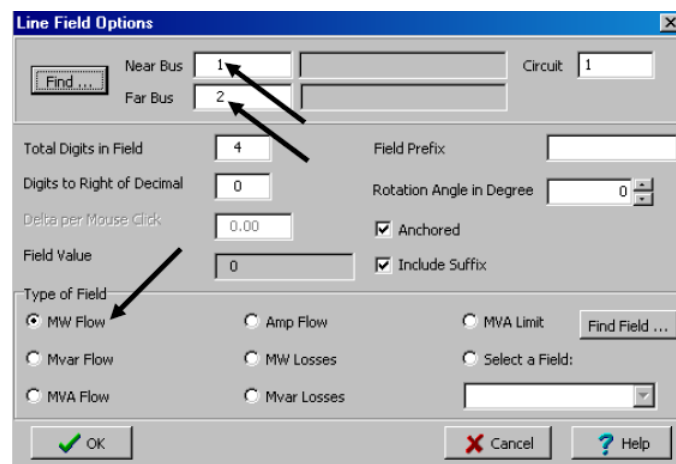


Fig. 29: Transmission Line Field Options

- Click **OK**. The MW Flow is displayed on the diagram.

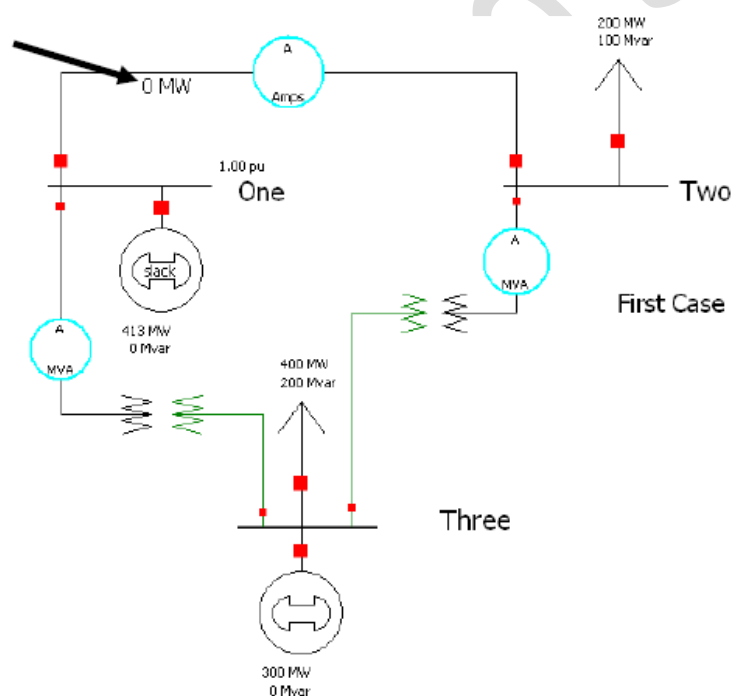


Fig. 30: Transmission Line Power Flow

- Now repeat the procedure left-clicking near both bus (2) and the transmission line between bus (1) and bus (2) in the location you want the power flow text to appear.



- Repeat the procedure again to insert **Mvar Flow** fields for the two locations.
- Once again, repeat the procedure to insert **MW** and **Mvar Flow** fields on the transmission lines joining buses (1) and (3) and buses (2) and (3) When you're done you should have the following

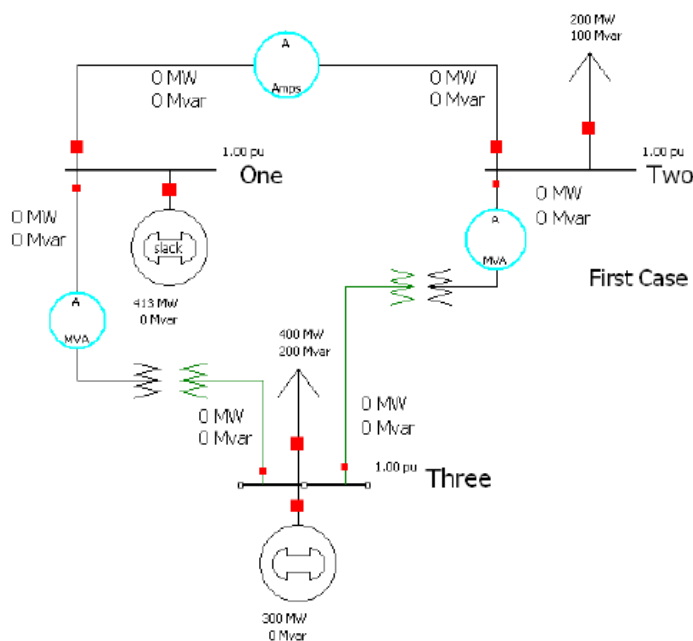


Fig. 31: Completed Power Grid.

15. Solve the Case (Run the Power Grid).

- Click on the **Run Mode** button in the **Mode** ribbon group. If you have any errors, a warning will appear.



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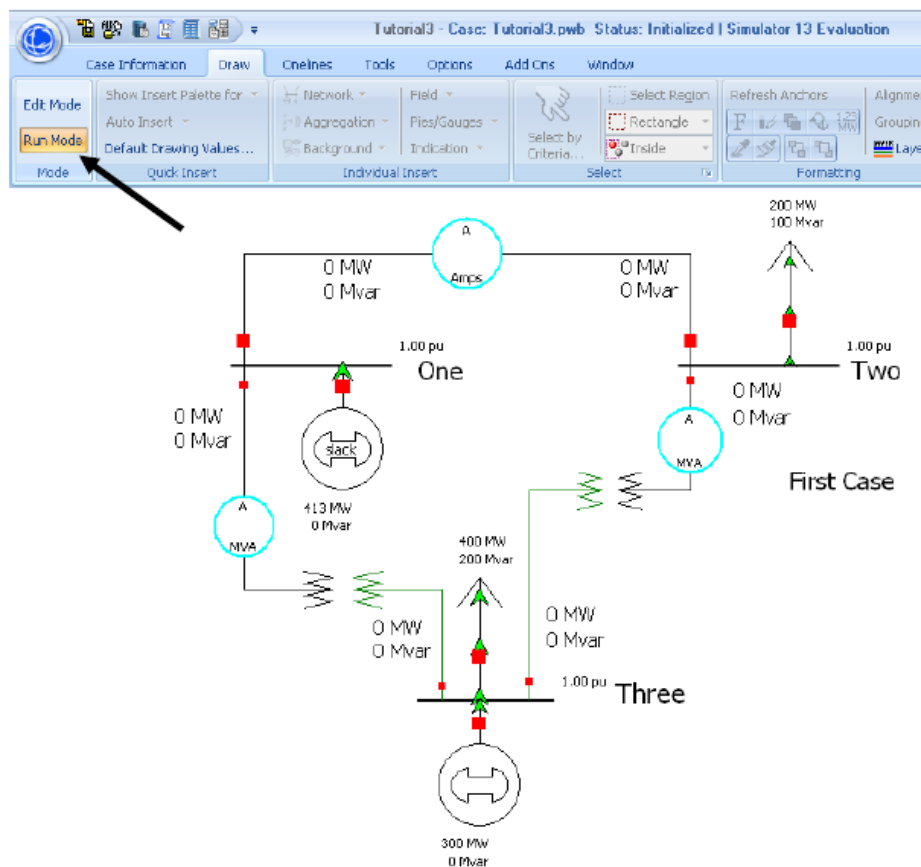


Fig. 32: Run Mode.

- Next, press the **Play**  button in the **Power Flow Tools** group on the Tools ribbon tab to begin the simulation. Your power grid and various values should look similar to this —

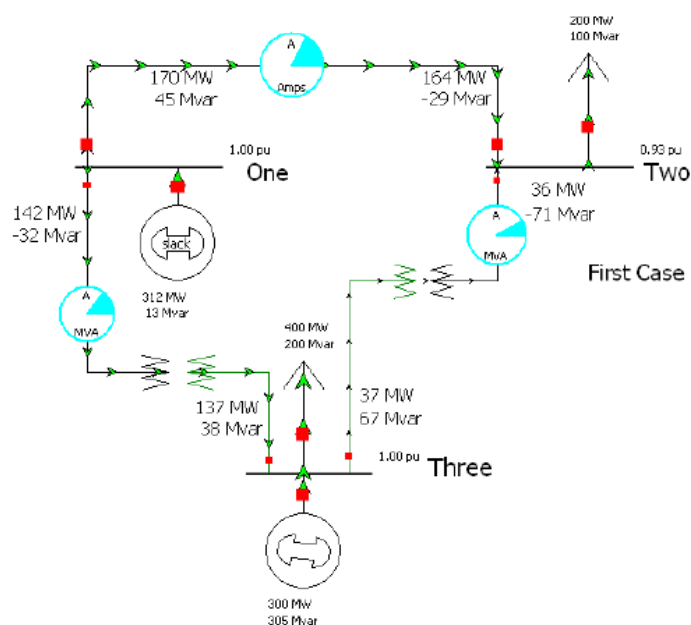


Fig. 33: Simulation in Run Mode.

- Just to play around, click on the circuit breaker between bus (3) and its connected generator. A hollow green box indicates it is open.
- Next, click on the circuit breaker on the transmission line between bus (1) and bus (2).

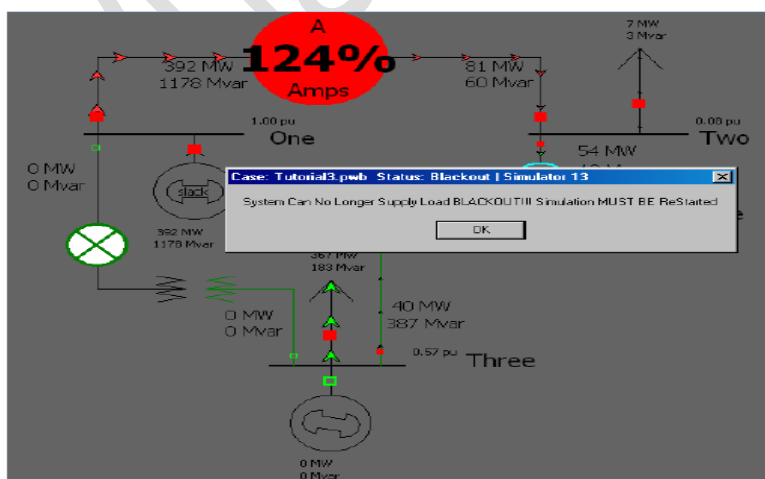


Fig. 34: Blackout

CONGRATULATIONS – YOU JUST BLACKED OUT