1. **Introduction**
   This handout will give you information about modeling circuits which contain diodes in DA and Accusim. You will also learn to use the waveform processor in Accusim which will give you useful information like input/output impedances etc.

![Fig. 1 Full wave bridge rectifier](image)
2. **Schematic Capture of the Full Wave Rectifier Circuit**

Let us consider the example of the diode bridge rectifier circuit of experiment 3 in your lab manual.

To draw the schematic open a DA window by typing the following at the Unix shell prompt:

```
% da &
```

Use the **Open Sheet** button on the palette menu to open a new sheet. Give a name, say *rectifier* and click OK.

In the experiment we are using the Motorola diode MUR105. DA has a library with models for various ICs and you can access them by their part numbers. The MUR105 is modeled with $I_s=0.2539\text{nA}$, $n=1.3973$, $R_s=32.9459\text{mohm}$, $C_{Jo}=49.914\text{pF}$.

Prof. Rebeiz believes that the series resistance of the diode is actually 0.1ohm and not 0.03ohm as the model suggests. To place an MUR105 diode, do the following:

- Use the menu item Libraries > MGC Analog Libraries > Display Libraries Palette to get the MGC Analog Libraries menu in the palette.
- In the palette menu, click on Analog M/S Utilities.
- Click on Add by Part Number. A dialog box will appear in the window. Enter MUR105 in the Part Number field and click OK.
- After a few moments, the diode will appear in the schematic window. Click on the LMB to place it at the desired place in the schematic window.
- You can view the SPICE model of the diode by selecting the diode and clicking on View/Edit Model in the Utilities menu. A dialog box will appear. Click OK and a window will appear showing the SPICE model of the MUR105 diode. You can close this window by double clicking on the top left corner of the window.

Place a resistor and capacitor as shown in the schematic attached. After placing the input and output ports, change the port names, resistor and capacitor values to the ones shown in the schematic. Once the schematic is done, check the sheet using Check > Sheet > With Defaults. After the sheet is checked successfully, create a viewpoint by clicking on Create Viewpoint in the MGC Analog Libraries menu and following the instructions given in the first handout on DA. Then, save the sheet using File > Save Sheet > Default Registration. You can now quit DA and simulate the circuit in Accusim.
3. Simulation of the Full Wave Rectifier circuit in Accusim

To run a simulation on the circuit you created in DA, open accusim using the following command at the Unix shell prompt:

```
% accusim rectifier
```

To run a simulation, follow the steps below:

3.1 Setting up the source:

- In the palette menu, click on TIME MODE.
- Enter 100U in the Time Step field and 100M in the Stop Time field. Click OK
- Click on the ADD FORCE button and a dialog box will open up in the schematic window.
- Enter IN in the Signal field.
- Click on the SIN button in the Force Type field.
- Enter 15.5 in the Magnitude field and 60 in the Frequency field. This sets the input as a semisolid of frequency 60Hz and a peak amplitude of 15.5V (11V rms).
- Click on Run in the pallet, click OK.

3.2 Running the simulation & Viewing the output voltage:

- You will see “Server:Running” in the status window. Once it is stopped, select OUT1 and OUT2 from the schematic window and click on TRACE in the palette menu. The actual output voltage is OUT1 – OUT2. To plot the difference between the voltages, we need to use the Waveform Processor.
- Click on the OPEN WF PROC button in the palette menu. A dialog box will appear in the window.
- Using the waveform processor, we can plot any mathematical function involving the currents and voltages in the circuit we simulated. The X axis of the plot is set by default to time in the time mode and frequency in the frequency mode. To plot the difference of the voltages OUT1 and OUT2, click on the Y button inside the dialog box.
- Click on the V button in the dialog box and a cross-hair cursor will appear in the schematic window. Locate the cursor on the OUT1 port or the wire connected to it and click on the LMB. You will see that v(/OUT1) appears in the WF_processor window.
- Click on the text field in the WF_processor window and enter the subtraction operator −.
- Click on the V button and place the cross-hair on OUT2 and click the LMB. Now, you should see v(/OUT1)−v(/OUT2) in the text field in the WF_processor window.
- Click on the CHART button in the WF processor window. If a dialog box appears, Select New Chart and click on OK.
- You will now see the plot of the difference of the voltages at OUT1 and OUT2 against time. This is the output waveform of the bridge rectifier.
3.3 Zooming and Cursor Features:

- To zoom into a particular portion of the plot, in the Chart window, click on the RMB and a pop−up menu will appear. Click on View>Area. A cross−hair cursor will appear in the window. Click on the LMB and drag it over the area you want to view. You can also use View>Zoom In and View>Zoom Out to zoom in and out of the plot.
- Zoom into two periods of the output waveform and note down the peak and minimum values and the ripple voltage.
- To find out the voltage drop across the diode, trace the voltage at the output port OUT2 which is across the diode D3. This gives you the diode turn−on voltage and the peak−inverse voltage.
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- To add a cursor in your chart window, click on the RMB and a pop−up menu will appear. Click on Chart>Add Cursor. A cross−hair cursor will appear in the chart window and you can place it wherever you want to by clicking on the LMB.

3.4 To view the capacitor and diode currents:

- To plot the current in the capacitor or the diode, first delete the text in the text field of the WF processor window. Click on the I button.
- Place the cross−hair on the capacitor and click LMB. Depending on where you click, the top plate or bottom plate of the capacitor, you can get a positive”or”negative” current. Make sure that your charging current is positive and discharging current is negative.
- Click on the CHART button in the WF processor window. Select New Chart from the dialog box and click OK. You will see a plot of the capacitor current with respect to time.
- Once again, zoom into two periods of the waveform and note down the charging/discharging currents and times.
- Do the same for the diode current and make sure that the current is positive.