University of California, Berkeley
EECS 117

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EECS 117A Demonstration 4
HFSS Simulation of a Transmission Line

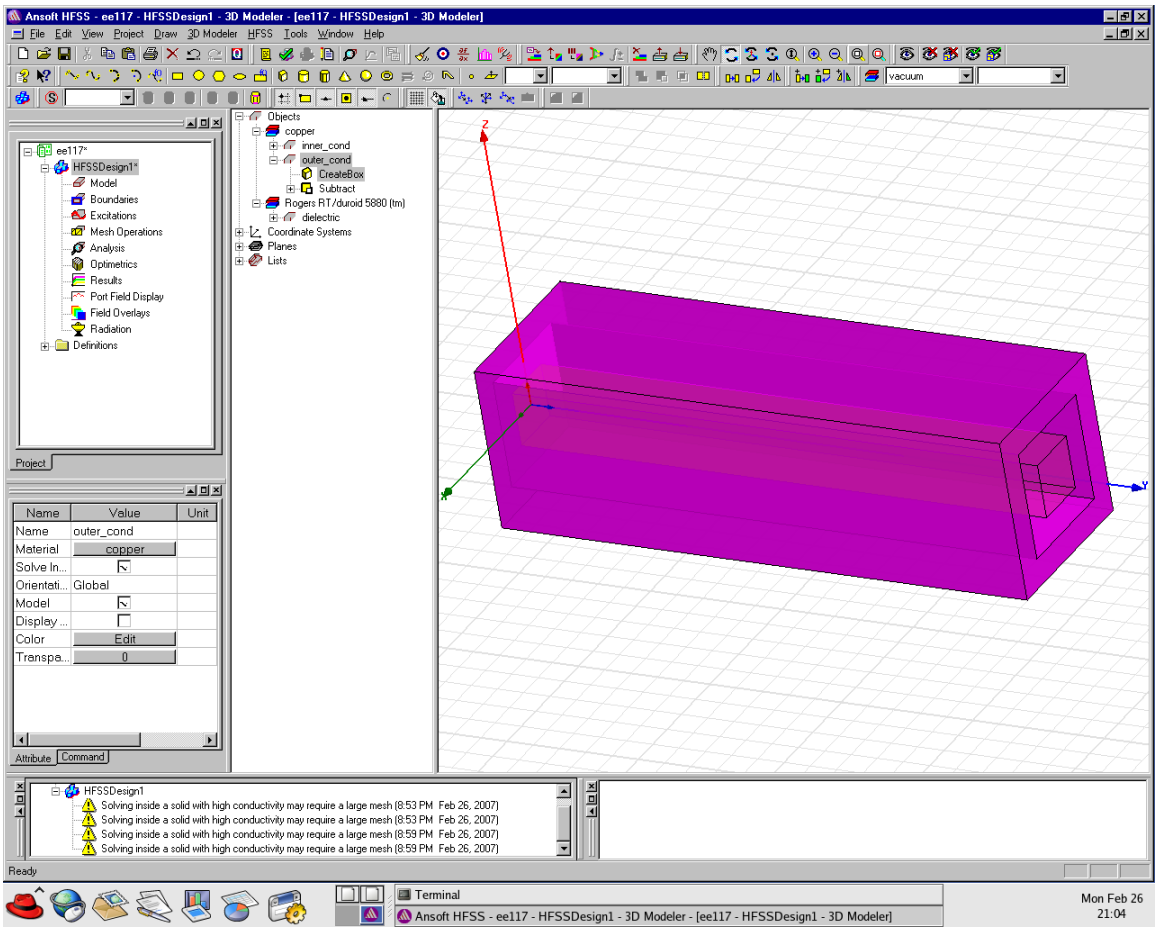
Getting started :

- Microsoft **Start > Programs > Ansoft > HFSS9**
- After program initialization, click on the blue icon for (**Insert HFSS Design**)
- Select the menu item **HFSS>Solution Type** , choose **Driven Terminal** click **OK**
- Select the menu item **3D Modeler>Units** , choose **mm** and click **OK**
- Select the menu item **3D Modeler>Grid Plane > XZ**

Draw the Structure :

- Select the menu item **Draw > Box**
- Using the coordinate entry field on the bottom right of the page enter the position:
  X : 0.5 , Y : 0 , Z : 0.5
  press enter and then at the same place enter
  dX : -1 , dY : 10 , dZ : -1
- Select the menu item **View > Fit All > Active view**
- In the vertical column next to the drawing field under the objects right click on **Box1 > Edit > COPY** and again right click on that **Edit > Paste** (Now you have **Box1** and **Box2** with the same size on top of each other and you need one of them later on to make a hole)
- Similar to **Box1** create **Box3** with (**X:1,Y:0,Z:1)** and **(dX:-2,dY:10,dZ:-2)**
- Similar to **Box2** create **Box4** with the same size of **Box3** and on top of it
- Similar to **Box1** create **Box5** with (**X:1.5,Y:0,Z:1.5)** and **(dX:-3,dY:10,dZ:-3)**
- On the object column click on **Box5** press **Ctrl key** and also click on **Box4 (** you selected both **Box5** and **Box4**) then go to **3D Modeler > Boolean > Subtract** and then subtract **Box4** from **Box5** (Blank part : **Box5** , Toll part : **Box4**)
- Do the same thing and subtract **Box2** from **Box3**
- Now you are left with three boxes : **1,3,5** you can click on their names on object menu and there will be a property window on the left side of the page and you can change the names **Box1>inner_cond , Box2>dielectric , Box3>Outer_cond** you should also change the materials assigned to them as following
  Inner_cond > Copper
  Dielectric > Rogers RT duroid 5880(tm) [with permittivity of 2.2]
  Outer_cond > Copper
  Also the **Solve Inside Boxes** should be checked for all of them. If you don't check that for the metals you are not going to capture the conductive losses.

- Now the layout so far should like like this :

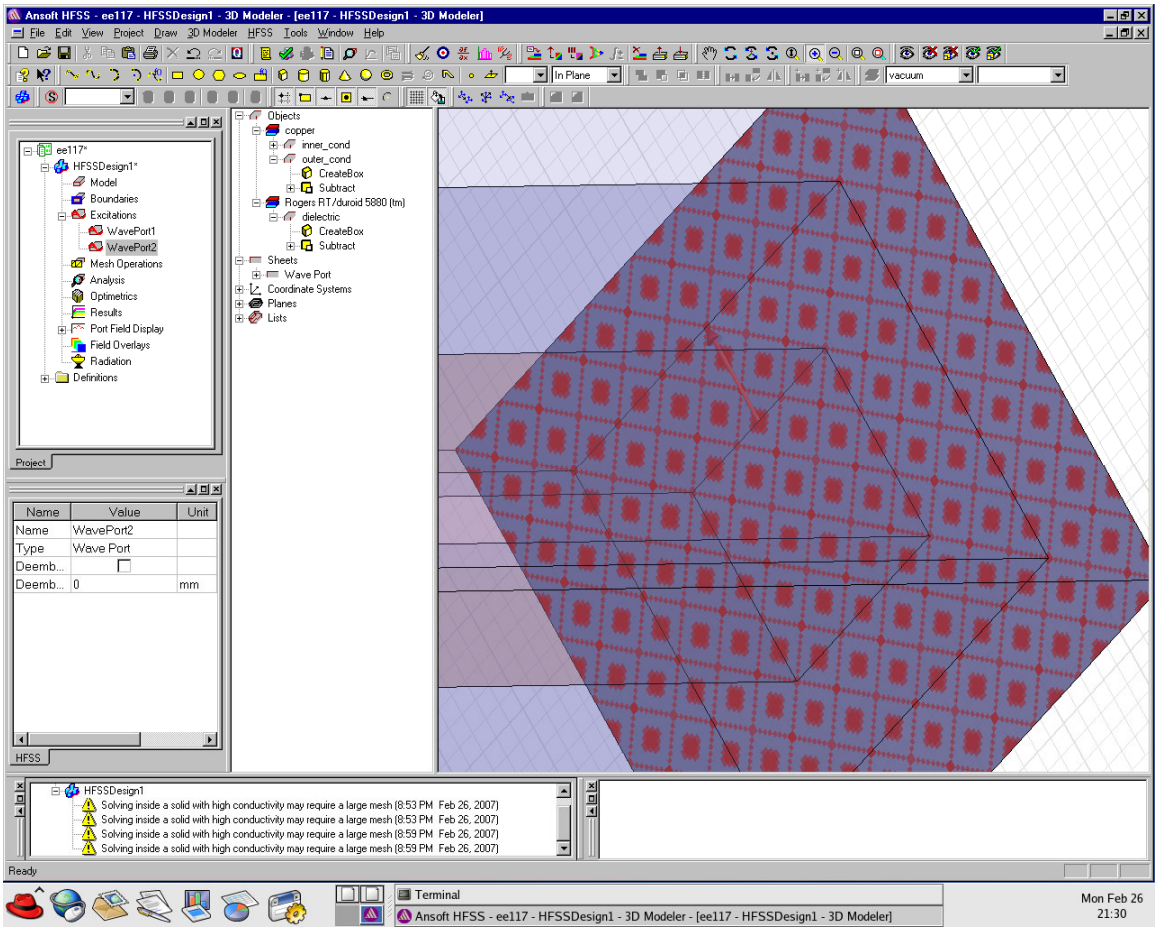


Creating the Wave Port Excitations :

- Draw a rectangle (**Draw > Rectangle**) with (**X:1.5,Y:0,Z:1.5)** and **(dX:-3,dY:0,dZ:-3)** your grid plane should be **XZ** to be able to draw that
- Select it, right click on it and choose **Assign Excitation > Wave Port** then click next choose 1 for number of terminals and select **new line** for the **integration**

line, now you have to choose two points for that line and these two points are the outer of inner_cond and inner of outer_cond. Once finished, you should have something like the figure in the next page. You can use Zoom and rotate icons on the top-right of the page

- Similarly draw port2 at (**X:1.5,Y:10,Z:1.5)** and **(dX:-3,dY:0,dZ:-3)**



Analysis:

- **HFSS > Analysis Setup > Add Solution Setup**
  In the **General** view :
  Frequency = 10GHz
  Maximum number of passes = 10
  Maximum Delta S = 0.01
  In the **Option** view :
  Minimum number of passes = 2
  Minimum converged passes=2
  Click **OK**
- **HFSS > Analysis Setup > Add Sweep**

Discrete type of sweep from 0.2GHz to 10GHz with the step of 0.2GHz

- Check the validity by **HFSS>Validation Check** and if there is no error go ahead and run the simulation **HFSS > Analyze All** . Wait a few minutes for the simulation to be done .

Results :

- **HFSS>Results>Solution Data> Matrix Data**
- Then choose **Z Matrix** , **Real-Imaginary**.
  Z11 is the impedance seen by port1 when port 2 is open circuited so it should be capacitive at low frequency. From the data calculate the capacitance at low frequency and express the capacitance per unit length in **fF/mm.** What's the **Q** of that capacitor?

  Similarly see the **Y Matrix** and since the 1/Y11 is impedance seen by port1 when port2 is short circuited. Calculate the inductance, inductance per unit length (**pH/mm**) and the **Q** of that inductance.

- Also check the Zo and see if it's equal to sqrt(L/C)?
- Plot the input impedance for an open and short circuit line over frequency by **HFSS> Results > Create Report> Im or Re (Z11 or 1/Y11)** and find at which frequency the line could be used as a resonator?
- Find the propagation constant of the line. What is the Q of the line in resonance?
- Find the quality factor of the resonator by sweeping the magnitude of impedance of a short line and observing the 3dB bandwidth.