

Laboratory 3

Defining structures in HFSS

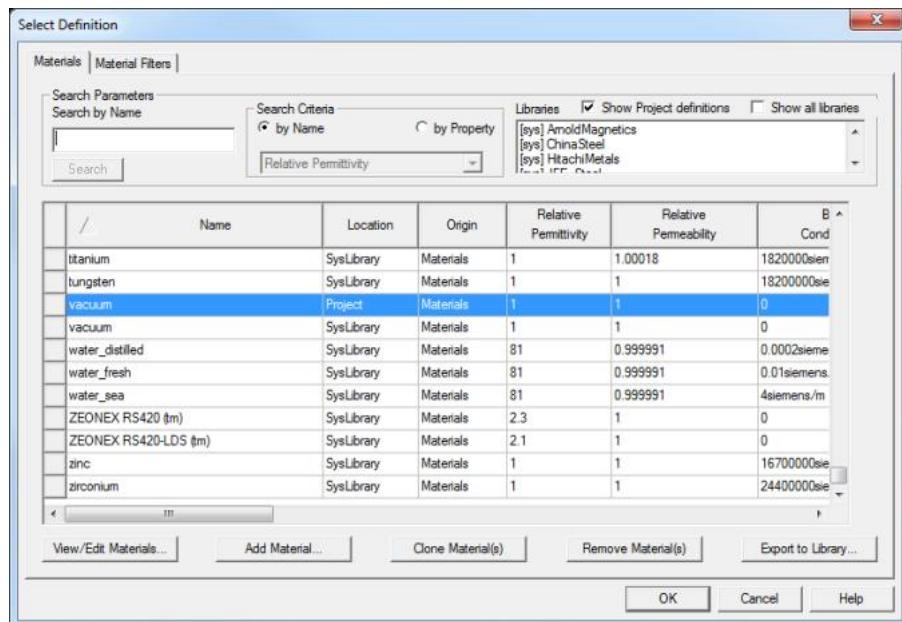
Start ANSYS Electronics Desktop, then click on HFSS icon. For help about starting HFSS or about basic operations refer to laboratory 2.

Assigning Materials

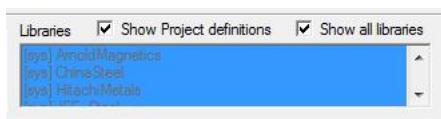
You can add, remove, and edit materials in two main ways:

- Using the **Tools>Edit Libraries>Materials** menu command.
- Right-clicking **Definitions>Materials** in the project tree (left) and selecting **Edit Library**.

The **Edit Libraries** window appears. The available materials are shown, with the Name, Location, Origin library, and parameter values.



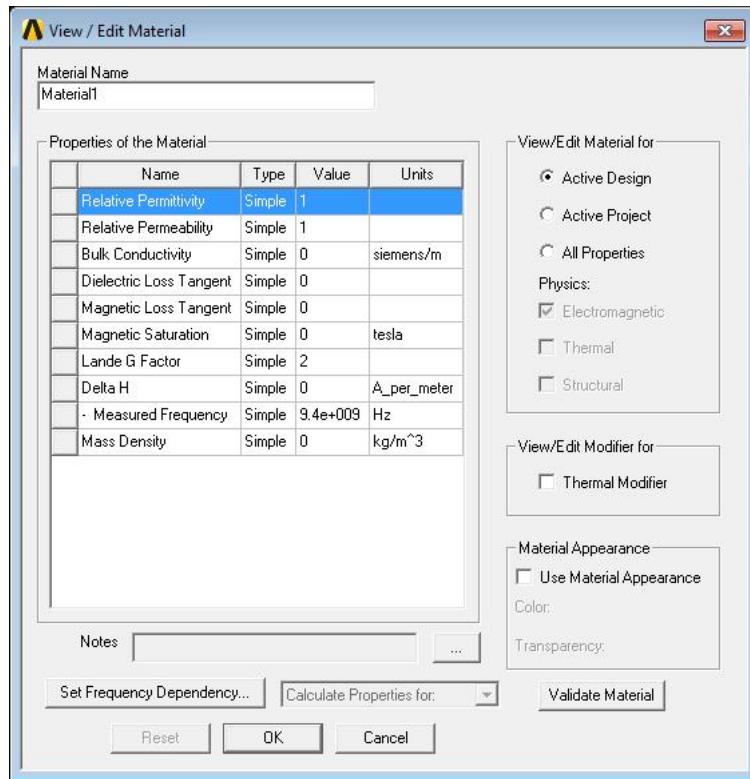
When the **Show all libraries** check box is selected, the window lists all of the materials in ANSYS Electronics Desktop's global material library as well as the project's local material library.



If the selected material is not the one you are searching for, do one of the following:

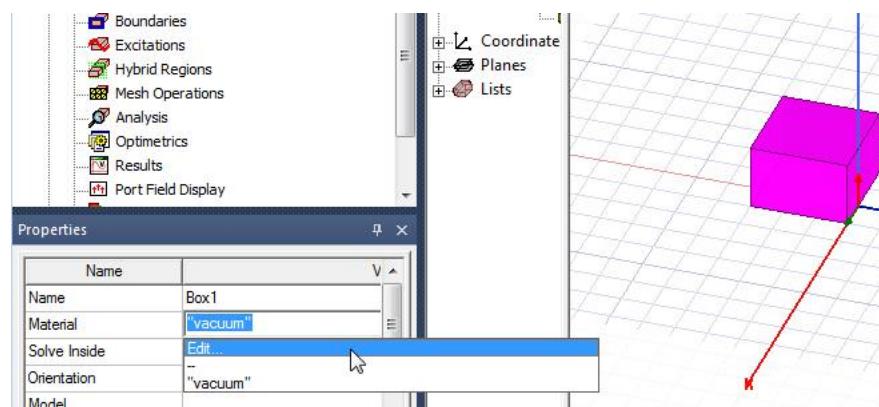
- Use the keyboard's arrow keys to scroll up or down the list of materials.
- Type a new material name in the **Search by Name** text box.

Double click the material you want, the **View/Edit material** window (below) is shown. Pressing Ok will add that material to the project (list in **Project tree>Definitions**).



To assign a material to an object, follow this general procedure:

1. Select the object to which you want to assign a material.
2. Do one of the following:
 - Click Modeler>Assign Material  or
 - Select the Material field in the **Properties panel** for the selected object (left, under the project tree), and select Edit... from the drop-down menu:
 - Double click the object (Box1, Cylinder1 ...) to show a pop-up **Properties window** and change the material from the drop down menu



Boolean Operations on Objects

Boolean operations include:

- Unite objects.
- Subtract objects.
- Create objects from intersections.
- Create an object from a face.
- Create an object from an edge.
- Split objects.
- Separate objects.

Uniting Objects

To join two or more objects into one object, use the Modeler>Boolean>Unite command. The new object has the name, color, boundary, and material assignment of the first object selected. The objects are united at the point of intersection.

1. Select the objects you want to join.
2. Click Modeler>Boolean>Unite, or in the Draw tab of the ribbon, click the Unite icon:



By default, the objects being joined to the first object selected are not preserved for later use. If you want to keep a copy of the objects being joined to the first object selected, do one of the following:

- Copy the objects, and then paste them back into the design after uniting them.
- Select Clone before unite in the Modeler Options dialog box. This option instructs the modeler to always keep a copy of the original objects being joined.

Subtracting Objects

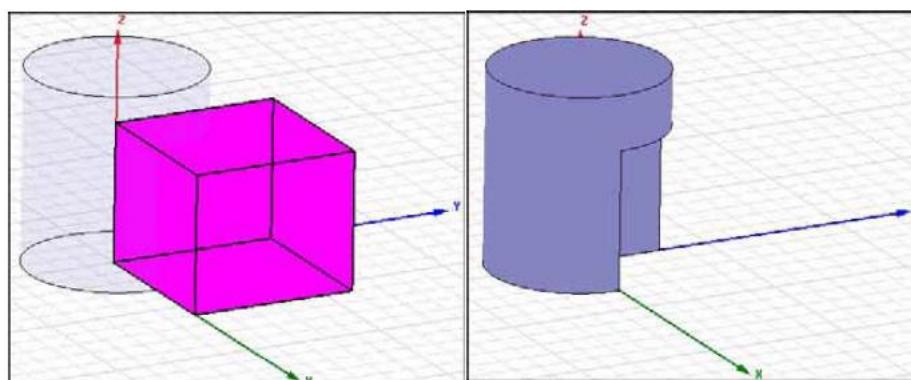
1. Select the object from which you want to subtract other objects.
2. Hold down the Ctrl key and select the objects you want to subtract.
3. Click Modeler>Boolean>Subtract or in the Draw tab of the ribbon, click the Subtract icon:

The Subtract dialog box appears.

Objects listed in the Tool Parts list will be subtracted from the object or objects listed in the Blank Parts list.

4. Optionally, select an object name in either list and use the left and right arrow buttons to move the object name to the opposite list.
 - Alternatively, type the name of object you want to subtract in the empty text box below the Tool Parts list, and then type the name of the object from which you want to subtract it in the empty text box below the Blank Parts list.
5. Optionally, select Clone tool objects before subtract. This instructs ANSYS Electronics Desktop to always keep a copy of the original objects being subtracted.
6. Click OK.

The new object (or objects) retains the name, color, and material of the first object selected.



Box subtracted from cylinder, the cylinder was selected first

Creating Objects from Intersections

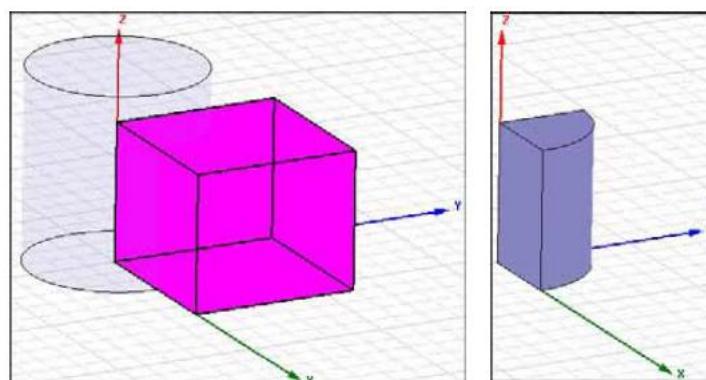
To create a new object from the intersection of two or more objects, use the Modeler>Boolean>Intersect command.

To create an object from an intersection:

1. Select the objects from which you want to take the intersection.

Warning If the objects you selected do not overlap, the result is a null object and both objects vanish.

2. Click Modeler>Boolean>Intersect



An intersecting box and cylinder.

Object formed from the intersection of the box and cylinder.

By default, the original intersecting objects are not preserved for later use. If you want to keep a copy of the objects that intersect the first object selected, do one of the following:

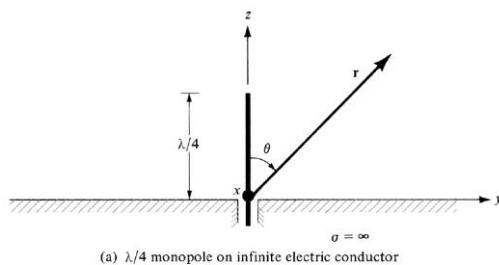
- Copy the objects, and then paste them back into the design after creating the new object from the intersection.
- Select Clone before intersect in the Modeler Options dialog box. This option instructs the modeler to always keep a copy of the original objects that intersect the first object selected.

Activity in the laboratory

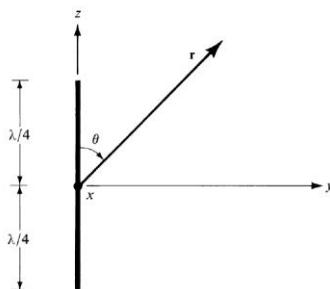
We practice drawing of typical antennas.

1. Half-Wavelength Dipole

Draw the half-wavelength dipole equivalent created by quarter-wavelength monopole on an infinite perfect electric conductor. Calculate the length so that the working frequency is around 1.9 GHz. The dipole/monopole is created from a copper wire with 1mm diameter, and the slot in the $\lambda/2 \times \lambda/2$ rectangular metallic wall has a 2mm diameter.



(a) $\lambda/4$ monopole on infinite electric conductor



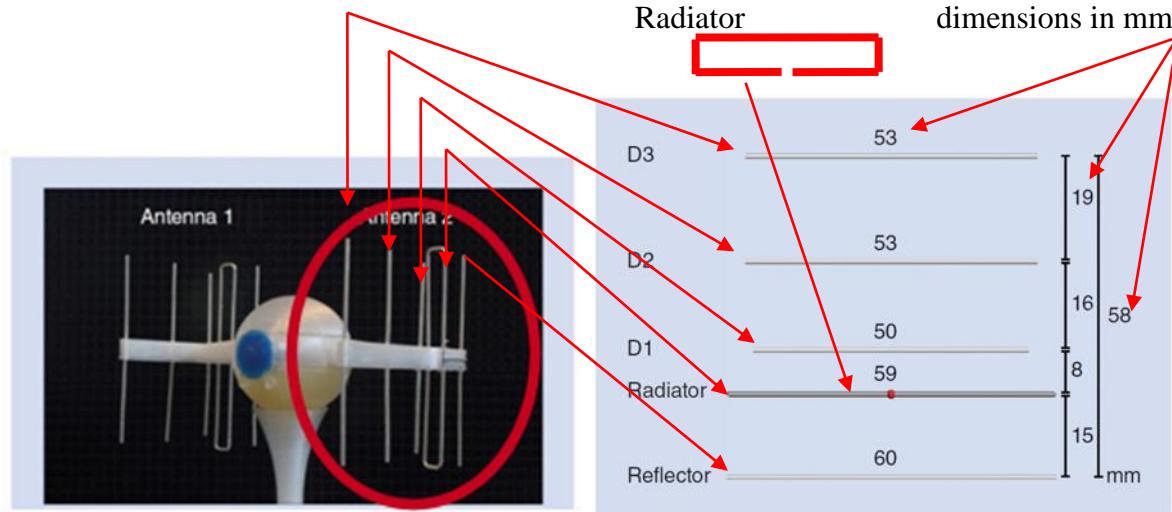
(b) Equivalent of $\lambda/4$ monopole on infinite electric conductor

Very Important! Draw the copper plate, then a cylinder (the slot), then subtract the cylinder from the plate to leave a cylindrical hole in the plate. Then pass the wire (1 mm diameter through that 2 mm diameter hole, remember Radius = Diameter / 2)

2. Yagi-Uda Antenna

Draw the five-element Yagi-Uda antenna in the following figure (3 Director wires, 1 Reflector wire, 1 Radiator loop) made of 1mm copper metallic wires. Working frequency is ~2.45GHz. Choose for the Radiator element a rectangular shape (59mm x 5mm) with a square cross-section conductor (1mm edge). The Radiator element is perpendicular on the

plane in which the Reflector and Director elements are placed. Don't forget to add a nonmetallic support element (any plastic material will do: in the library one of the "poly" materials: polyethylene, polyimide, polystyrene ...).

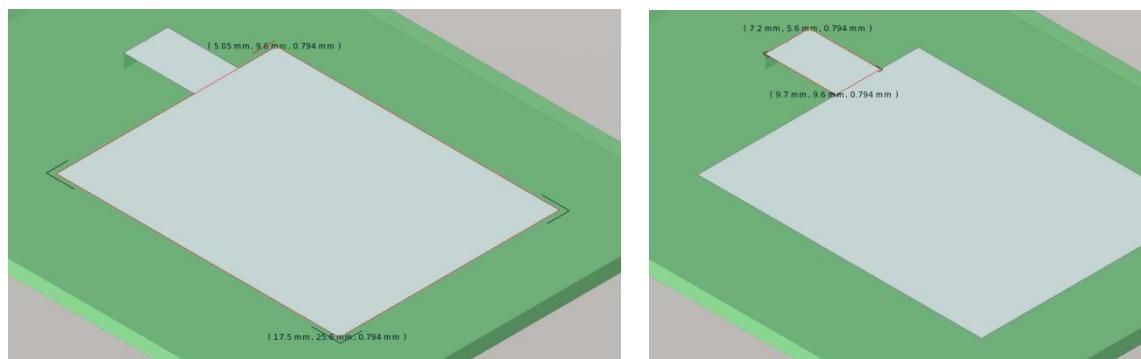


Very Important! The radiator loop can be created either by:

- uniting 5 square section wires (leaving a small 1 mm gap in the middle for input connection) or,
- starting with a thick rectangular plate and subtracting two smaller rectangular plates, one for the inner loop, one for the 1 mm gap.

3. Microstrip Patch Antenna

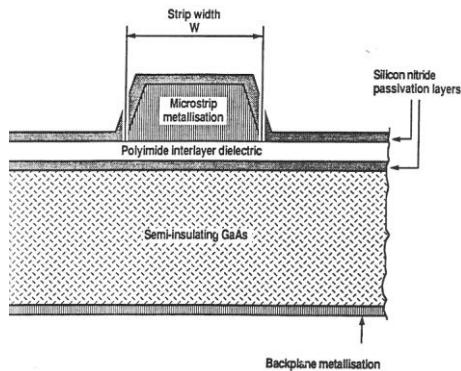
Draw the microstrip patch antenna with the dimensions of $12.45 \times 16\text{mm}$, with a $2.5 \times 4\text{mm}$ feeding line, as in the following figure (working frequency is $\sim 7.45\text{GHz}$, zoom on the figure for coordinates of the corners).



This antenna is placed on a substrate with $\epsilon_r = 2.2$ and the height of $h = 0.794\text{mm}$ (material: Duroid). The substrate is a $40 \times 40\text{mm}$ square. Draw the antenna in the simple (plane) model with PEC (Perfect Electric Conductor, 0 mm thickness)

4. Microstrip Patch Antenna - Bonus points

Draw the same microstrip patch antenna in the technologic accurate version with 0.1mm thick copper metallization on the same type of substrate and passivation (deposition of an insulating layer all over the structure,) with 0.01mm thick Si₃N₄ (materials from the Standard Material Library silicon_nitrate).



5. Submit results

Archive then submit the 4 projects

Very Important! Remember to "Rotate" your structure to look at it from different angles to check correct alignment of different objects.

Very Important! Usually better results (when drawing objects) can be obtained drawing a little sketch (with coordinates!!) on paper and using the **Dialog** input mode (press **F4** function key to activate it or **F3** to deactivate it). Drawing with the mouse on screen is a lot less accurate.