

Laboratory 2

Defining structures in HFSS

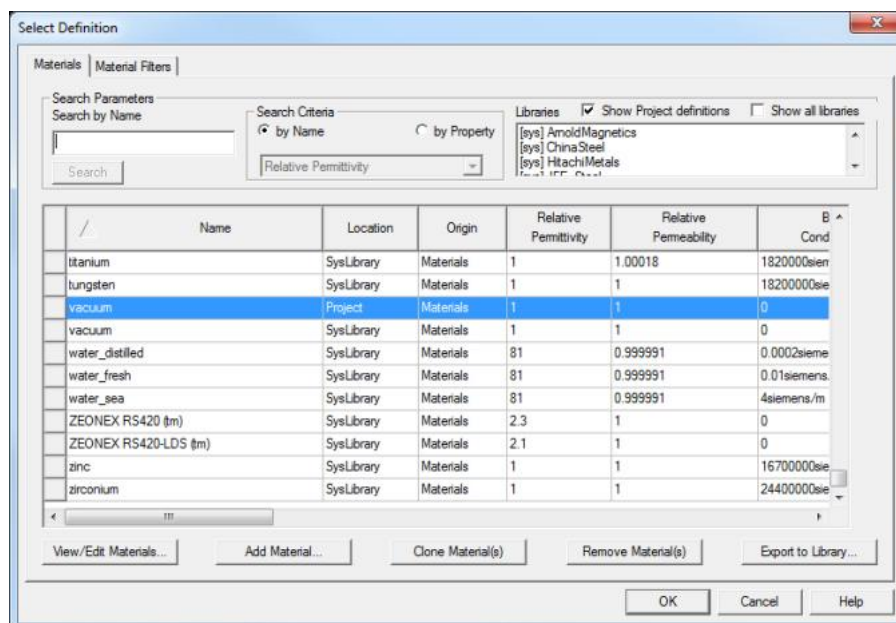
Start ANSYS Electronics Desktop, then click on HFSS icon. For help about starting HFSS or about basic operations refer to [laboratory 1](#).

1. Assigning Materials

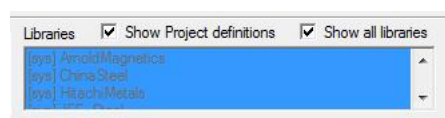
You can add, remove, and edit materials in two main ways:

- 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.



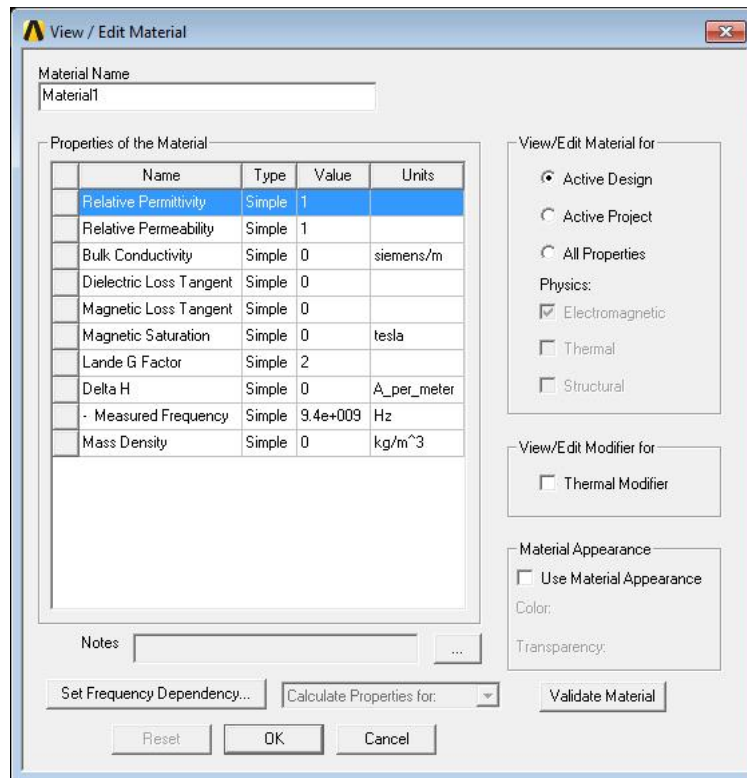
When the **Show all libraries** check box is selected, the window lists all of the materials in ANSYS Electronics Desktop's global material library as well as the project's local material library.




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

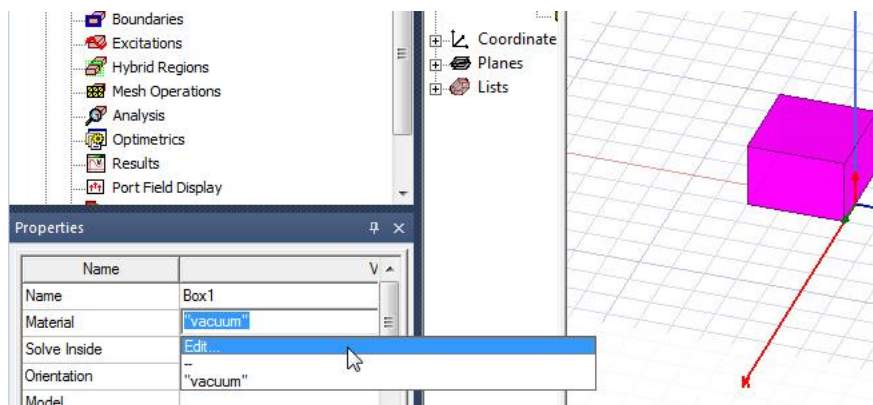
- Use the keyboard's arrow keys to scroll up or down the list of materials.
- Type a new material name in the **Search by Name** text box.

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



2. Boolean Operations on Objects

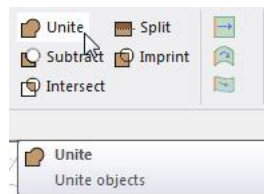
Boolean operations include:

- 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

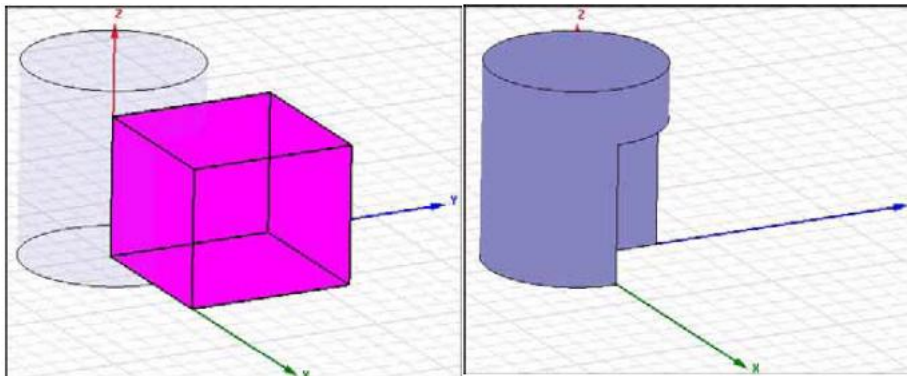
1. Select the object from which you want to subtract other objects.
2. Hold down the Ctrl key and select the objects you want to subtract.
3. Click Modeler>Boolean>Subtract or in the Draw tab of the ribbon, click the Subtract icon:

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

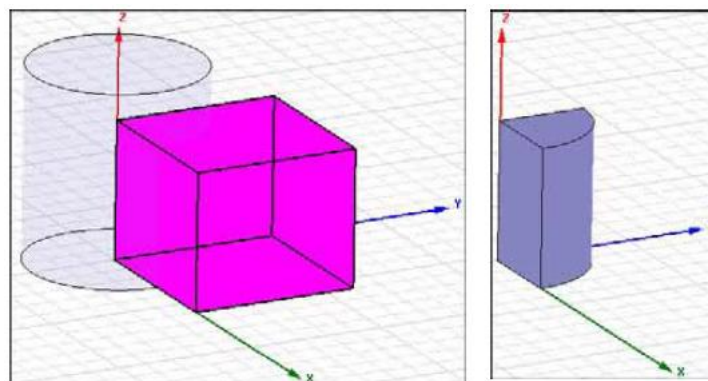
To create a new object from the intersection of two or more objects, use the Modeler>Boolean>Intersect command.

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:

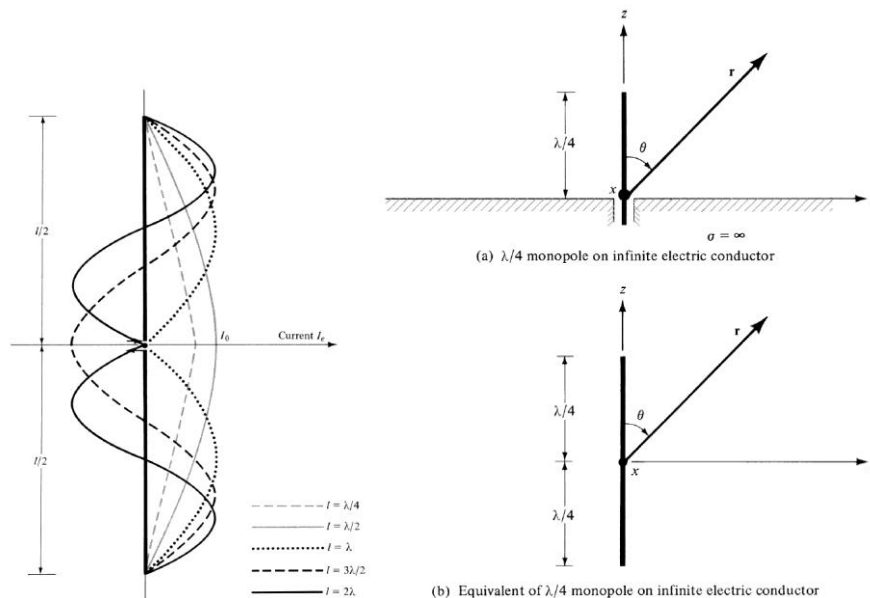
- Copy the objects, and then paste them back into the design after creating the new object from the intersection.
- Select Clone before intersect in the Modeler Options dialog box. This option instructs the modeler to always keep a copy of the original objects that intersect the first object selected.

3. Activities in the laboratory

We practice drawing of typical antennas.

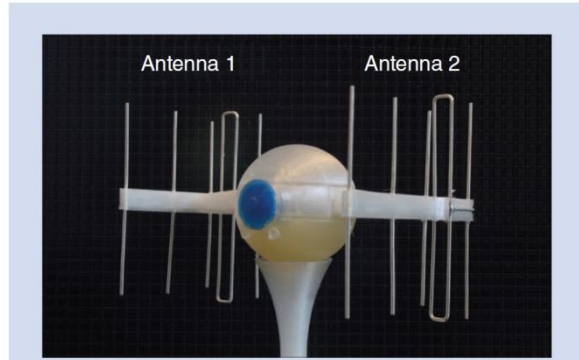
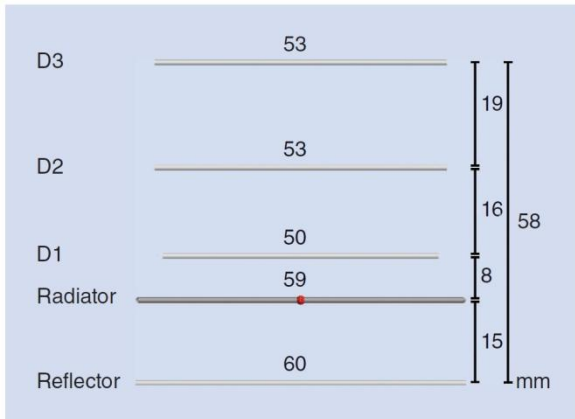
3.1. Half-Wavelength Dipole

Draw/simulate the Half-Wavelength Dipole and the 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.



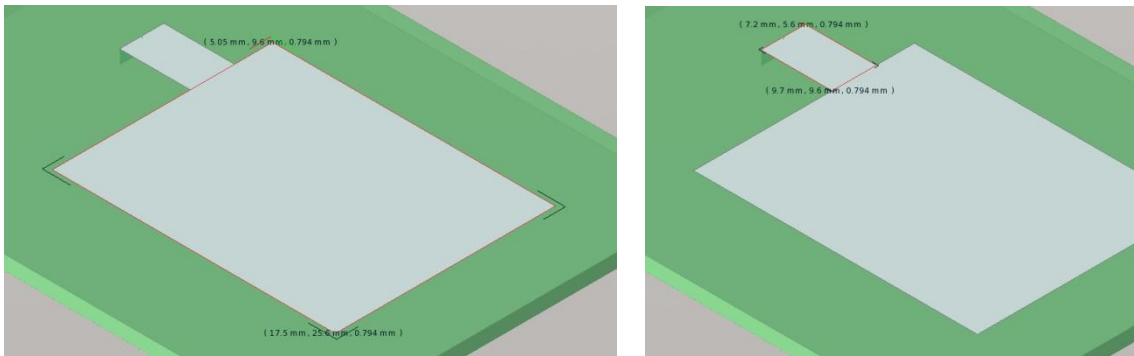
3.2. Yagi-Uda Antenna

Draw/simulate the five-element Yagi-Uda antenna in the following figure made of 1mm copper metallic wire. Working frequency ~ 2.45 GHz. 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 elements.

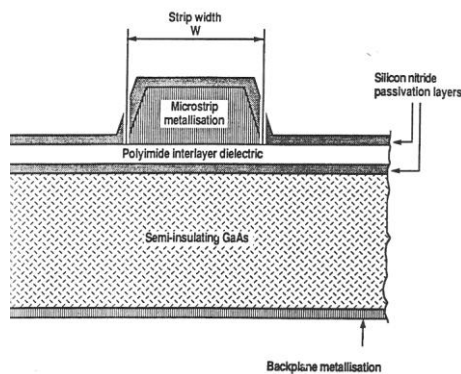


3.3. Microstrip Patch Antenna

Draw/simulate the microstrip patch antenna with the dimensions of 12.45×16 mm, with a 2.5×4 mm feeding line, as in the following figure (working frequency ~ 7.45 GHz).



This antenna is placed on a substrate with $\epsilon_r = 2.2$ and the height of $h = 0.794$ mm (Duroid). The substrate is a 40×40 mm square. Draw/simulate the antenna in the simple (plane) model with PEC **and** in the technologic accurate version with 0.1 mm copper metallization on the same type of substrate and passivation with 0.01 mm Si_3N_4 (materials from the Standard Material Library silicon_nitrate).



4. Assigning Boundaries in HFSS

Boundary conditions specify the field behavior at the edges of the problem region and object interfaces. HFSS designs have different menu options for boundaries. Within the context of HFSS, boundaries exist for two main purposes:

1. to create either an open or a closed electromagnetic model or,
2. to simplify the electromagnetic or geometric complexity of the electromagnetic model.

In an open problem, an air volume encompassing the outer radiating surfaces is modeled by a surrounding object. Radiation boundary conditions (ABC, PML or FEBI) are assigned to the outer radiating surfaces (i.e., faces of the region) to absorb all outgoing waves.

Anisotropic Impedance	Represents a boundary condition used to replace a surface a planar screen or grid with periodic geometry.
Aperture	Represents a hole in a metallic sheet assigned as an IE Region.
Finite Conductivity	Represents an imperfect conductor.
Fresnel (SBR+)	Represents either a perfect absorbing boundary or a user-defined Fresnel table file that describes a good approximation of the reflection of an arbitrary wavefront off a surface. Supported for driven modal/terminal and SBR+ solution types.
Half Space	Represents a background comprising a dielectric half space. For antenna and scattering problems in HFSS in which all objects are assigned as Hybrid IE Region.
Impedance	Represents a resistive surface.
Layered Impedance	Represents a structure with multiple layers as one impedance surface.
Linked Impedance	Represents a data link to an isotropic or anisotropic impedance boundary in another design. These can include infinite ground planes and shell elements.
Lumped RLC	Represents any combination of lumped resistor, inductor, and/or capacitor in parallel on a surface.
Master	Represents a surface on which the E-field at each point is matched to another surface (the slave boundary) to within a phase difference.
Perfect E	Represents a perfectly conducting surface.
Perfect H	Represents a surface on which the tangential component of the H-field is the same on both sides.
PML	Represents an open boundary condition using several layers of specialized materials that absorb outgoing waves.
Radiation	Represents an open boundary by means of an absorbing boundary condition (ABC) that absorbs outgoing waves.
Slave	Represents a surface on which the E-field at each point has been forced to match the E-field of another surface (the master boundary) to within a phase difference.
Symmetry	Represents a perfect E or perfect H plane of symmetry.