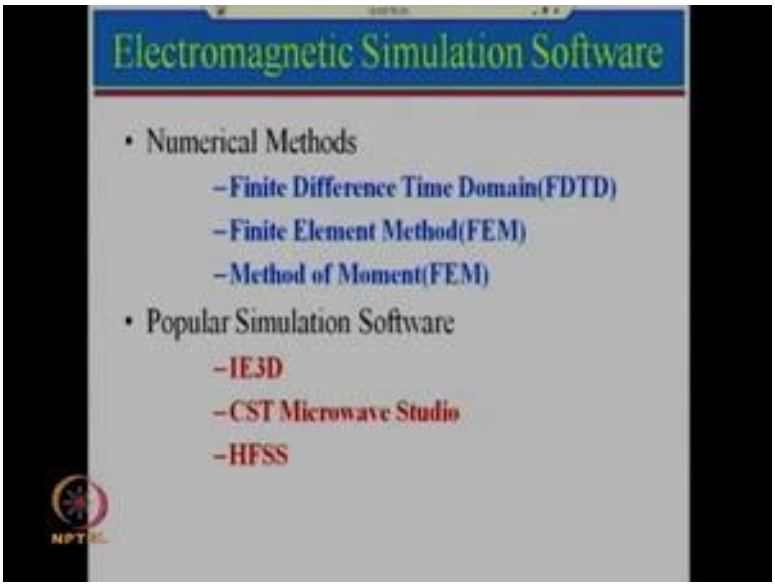
**Antennas**
**Prof. Girish Kumar**
**Department of Electrical Engineering**
**Indian Institute of Technology, Bombay**

**Module - 12**
**Lecture - 53**
**IE3D Session TA-I**

Hello, I am Rinkee Chopra, I am a PhD student at IIT Bombay, also I am a teaching assistant for this course. So, today I am going to take a lecture on computational stimulation software. So, let me start the lecture on computational stimulation software.

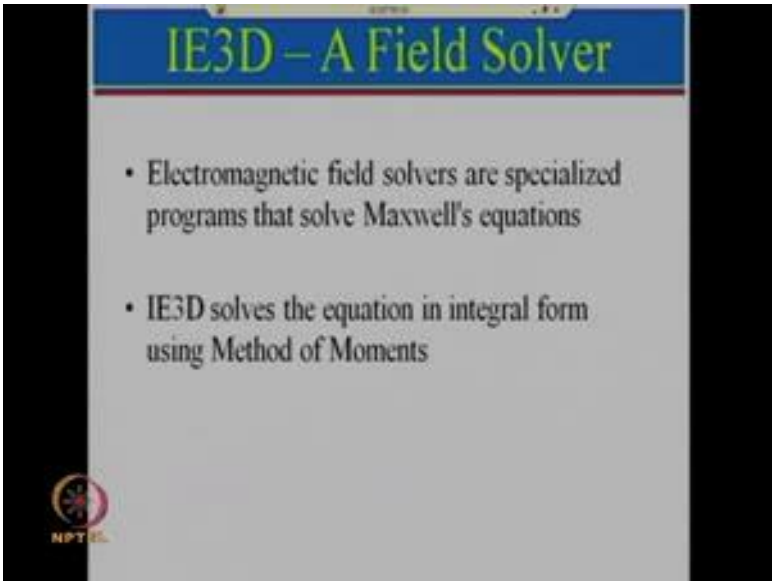
(Refer Slide Time: 00:34)




As we all know to solve any problem in electromagnetic, we use Maxwell equations. So, Maxwell equations are basically defined in 2 form differential equations or integral equations, but to solve any complex problem, it is difficult to explain with the help of Maxwell equations. So, many numerical techniques have been defined like finite difference time domain method finite element method; method of moment. So, finite element method and finite difference time domain method; both use different equations to solve any electromagnetic problem whereas, the method of moment it uses the integral equation to solve Maxwell equations. So, to solve these equations on the background many software have been designed like IE3D, CST microwave studio and HFSS. IE3D stands for integral equation 3 dimensional software; CST microwave studio stands for

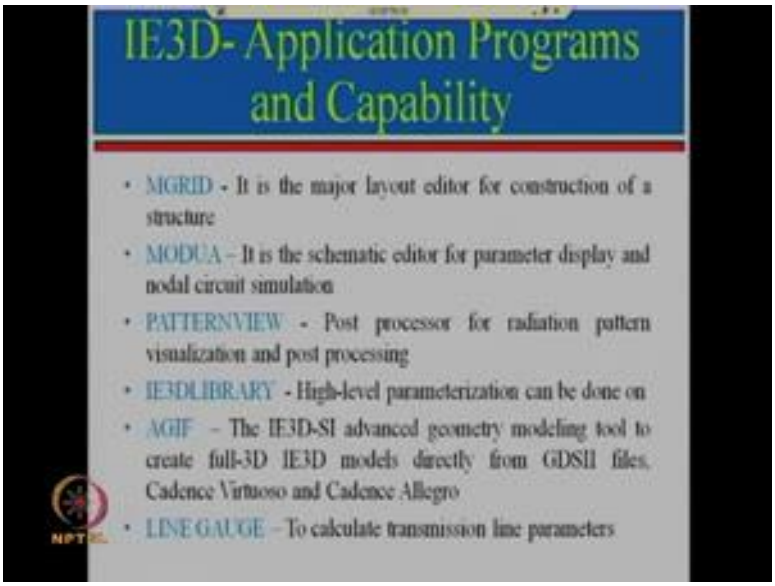
computer simulation technology microwave studio and HFSS stands for high frequency structure stimulation.

(Refer Slide Time: 01:46)




Let me now start with the basics of IE3D. IE3D is a field solver which solves the electromagnetic field equations with the help of integral equations it utilizes the method of moments which is based on the greens function which is basically based on the weighted complex residual method.

(Refer Slide Time: 02:06)

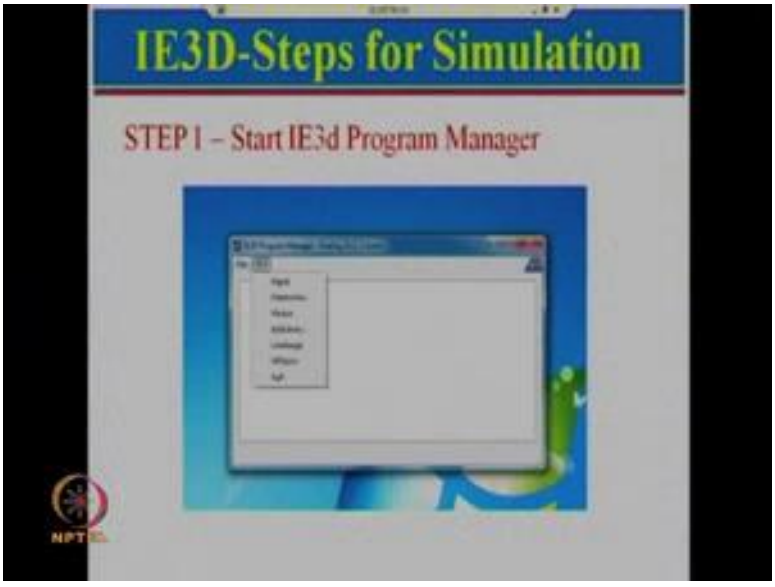


Now, let me tell about the IE3D application programs and capability, now if you open the IE3D interface, you will see many options like one is MGRID. So, MGRID is a basic major layout editor for construction of a structure in this basically we design a polygon we edit a polygon we see the current distribution and such type of things.

The second is the MODUA it is the schematic editor for parametric display and for the co circuit simulation like if we want to simulate a antenna with the lumped elements like RLC then with the help of MODUA, we can simulate this then pattern view it is a post processor which is used to analyze the post processing parameters like current distribution s parameters and other things next is IE3D library. So, IE3D library is used to realize the high level parameterization. Next is AGIF that is used to generate the 3D structures in the form of cadence file then is line gauge, line gauge is used to calculate the transmission line parameters.

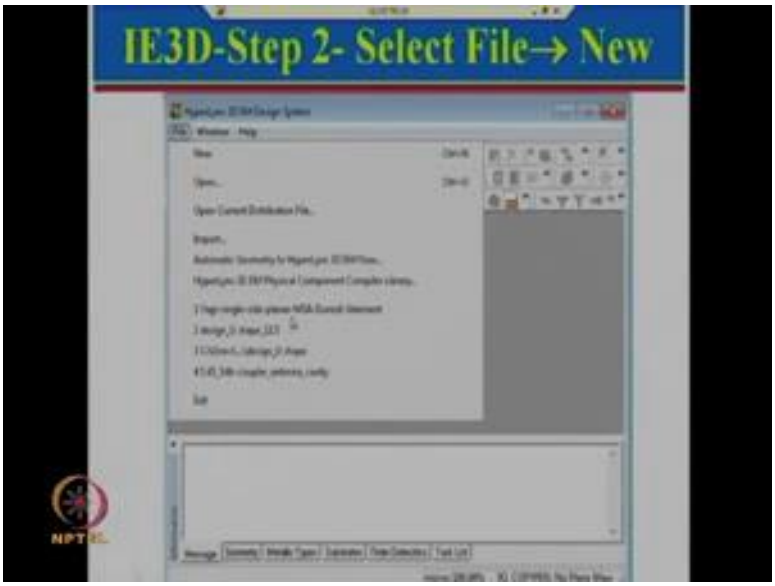
So, let us start with IE3D. So, first to start IE3D, we need to IE3D program manager.

(Refer Slide Time: 03:19)



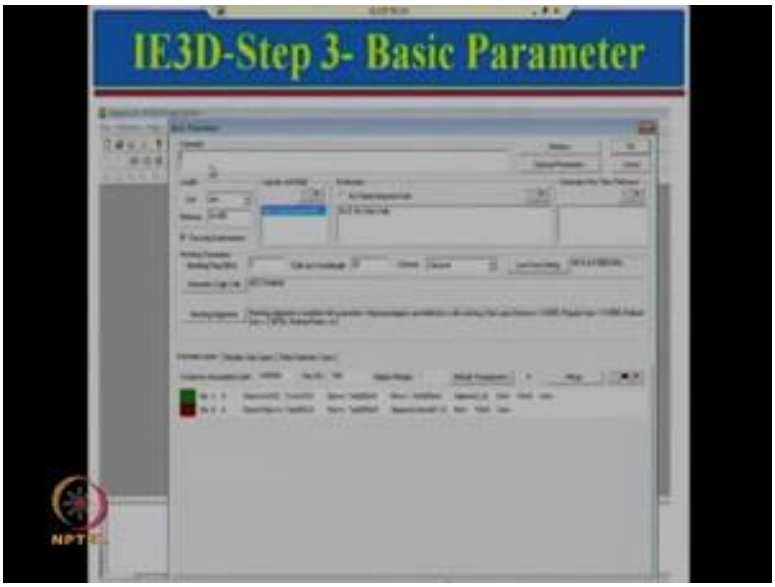

Now, when you open program manager you will click here you will find MGRID pattern view MODUA, IE3D library line gauge MD spice and AGIF and I have already told you what is the significance of each particular sub menu in this menu.

(Refer Slide Time: 03:36)




The second step when we open the MGRID one window pop up in the file menu we want to create a new project when we use to open the file menu and to create a new project just click on the new part.

(Refer Slide Time: 03:55)



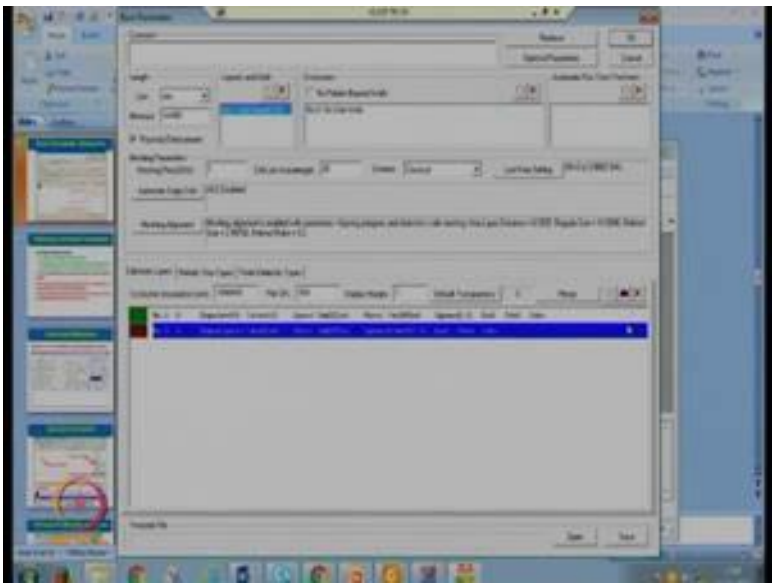

When you open the new part then one window will pop up and it will look similar to this window this is called as the basic parameter window, now if you see there are many such windows here, first one is comment, this is just to give the comments if you want to mention like if you are defining any substrate like FR 4 and if you want to give the

details of this particular substrate then you can mention here FR 4 substrate and such type of things.

Then second is length - in this the unit is given, here you can set different units like mm, micrometer, etcetera, this is minimum the minimum length, it can tolerate that is given now second is a layout and the grid the resolution of the layout and grid is given then the enclosure part and the next part is a matching parameters. So, here all the matching parameters are given like matching frequencies, cells per wavelength and the scheme which is used to simulate and the low frequency that is low frequency it means here it is given NF3 at 0.002 gigahertz, it means that at 0.002 gigahertz, it is creating 3 frequency points. Then automatic edge cell, the automatic edge cell is used to define the meshing towards the edges. So, if we enable this particular function then it provides finer meshing towards the edge which is helpful in our simulation and which provides us better accuracy.

Then this is mesh alignment, this is the comment related to the mesh alignments and the next part is the substrate relate specifications the first one is the substrate layer, now if you see here the by default 2 layers are given. So, the lower one is the ground layer if you see here it is written z top equals to 0 FSLR equals to 1. So, this one is ground layer. Now let me show the enter phase first, I am just opening MGRID.

(Refer Slide Time: 06:01)

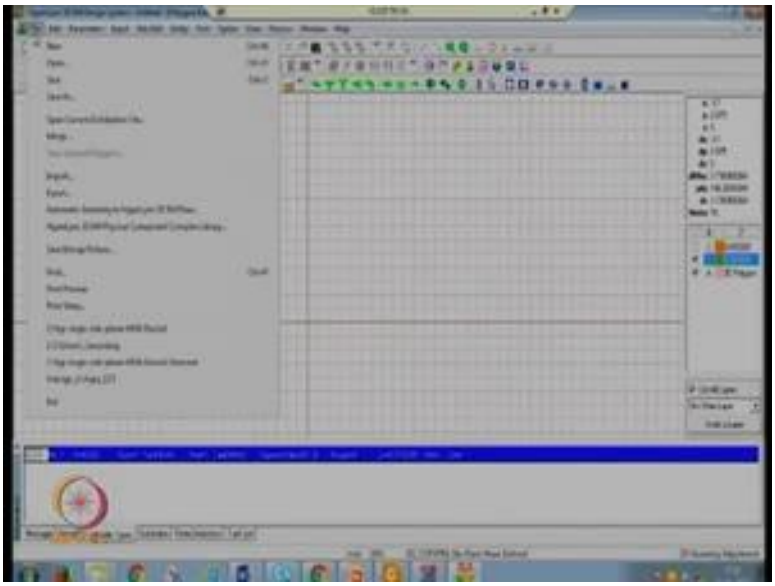


This was the option, I am creating a new projects. So, here is the window, now if you see this lower most layer in this, if you see one window pops up. So, here you need to define the specification if you are defining any substrate. So, in this case if you see for the ground substrate it is by default its z top will be 0 and you cannot modify the stop coordinate of its z axis and the epsilon r is 1 and the conductivity is very high that is why it is ground plane.

Now, if you see the second layer that shows the upper half which is air. So, by default, 2 layers will be selected, now if you want to define a substrate then you need to define a substrate, this one is to insert a layer these 2 options are to insert a layer and the third one is to delete the layer. So, just to define a substrate here you need to give the comments if you want to give the comments for the substrates or if you want to define a substrate then you need to define a substrate here. So, let me take a substrate let us take the substrate is RT Duroid 5880 with thickness of 0.8. So, my thickness is 0.8 in that case z top should be 0.8 because the lower most z top is 0. So, it should be 0.8, the epsilon r for RT Duroid 5880 is 2.2. So, I am putting that 2.2 and the los tangent for RT Duroid 5880 is 0.001.

The rest of the things will be as it is because these are the things which are given to us for RT Duroid 5880 then press ok, now if you see, one layer is created above z top equals to 0. So, this is how we introduce a new layer now if you press ok, this is my MGRID window.

(Refer Slide Time: 08:06)



Now, here you can see, this particular section is called as layout editor window and this one is called as status window, now if you can see here if we are moving our cursor, the position of x, y and z, d x, d y, d z, these are changing. So, this is showing the status of the cursor and the d x and d y are the respective location with respect to the last point. Now if you see this section this is called as the layer window, in this section 3 windows are given this is corresponding to 0.8, this is corresponding to the ground layer, in this section you can check different type of layers like in elevated mode the whatever layer is you have selected that will be shown on the stock and the other layer will be shown on the bottom, but in actual scenario, they will be on the top whatever in whatever way you design.

Now, if you want to change it, if you do not want to show the other layers, you were just want to show only that layer which you have selected then you select this option or if you want to show other layers in the form of contuse then you can select those things. So, in this way you can proceed, in the last section this is called as the information window and here it shows the operations that you perform plus the details of geometry and the substrate. Now here you see these 3 layers which were defined, these are given and the metallic type these type of details are given here. Now if you see on this window there are multiple menus. So, this menu if you see this is file menu, this is basically the conventional menu now if you want to create a project. So, in the combination file you can create the file and you can open the file, save and merge different files. So, same menus are available here you can see here, this one is new, open, save, save as, etcetera.

The second is edit. So, in the edit part you can draw the polygon, you can copy, you can paste and you can do such type of operations, the next is parameter window in this you can define different parameters, you can modify parameters, you can play around with the parameter like if you want to change the color of parameter then you can change from here and if you want to display multiple parameter if you want to do such type of operation then such type of operations you can do from here.

The next is the input part this input menu mainly deals with the vertex related operations. So, if you want to define the particular if you know the vertex and if you want to define your polygon in terms of vertex then you can use this particular menu. The next is the advance edit option. So, advance edit is used to accommodate the additional edit related operations. So, different menus are introduced in this particular section like if you want

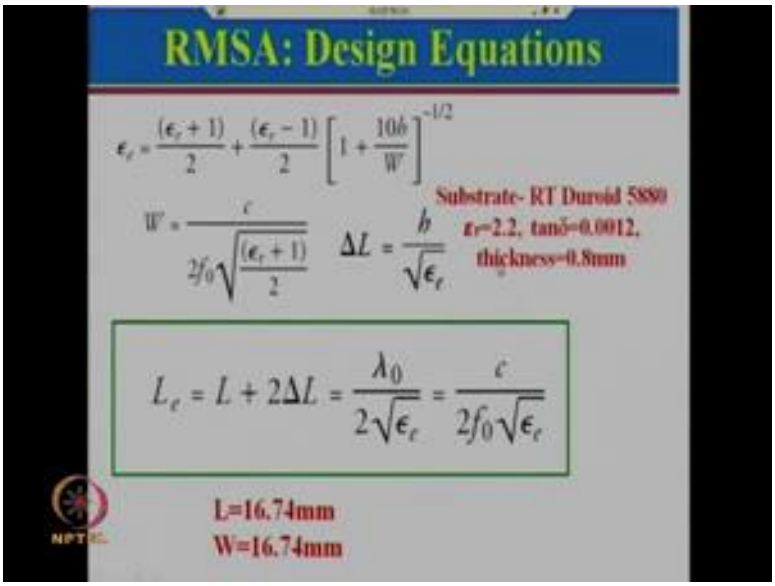
to check the electrical connections, if you want to dig a hole or such type of things you can do in this particular section. The next is entity. So, this is used to create the different types of polygons pre defined polygons like if you see here this is rectangle, symmetrical t junction, y junction, etcetera these types of geometries you can create from here.

The next is related to port, this is used to excide the port, you can find different type of ports you can create a port, you can change the location of port and you can see what location it is from the port properties and also you can delete from this section. The next is the optimizer, now if you want to optimize a particular geometry if you want to optimize a particular variable then you need to use this particular option, the next is the viewpoint. So, if you want to change the view of this particular layout editor then you can change with the help of this particular menu

Next one is process in the process you use this to simulate and to check the post process parameter like S parameter, current distribution, distribution pattern and such type of things whichever is required to process any antenna or microstrip circuits. Next is the window. So, this is used to check the different type of window like if you want to see the geometry in the different window then you need to select this option if you want to see the meshing mesh view then you need to see this option, if you want to check the current distribution part then you need to select this option and like that. So, that is all. So, let me see here.

Now, since let us start with this particular software. So, substrate so far we have designed, now if we want to design any particular microstrip circuit; let us say we want to design a rectangular microstrip antenna. So, we need to have one thing is we need to have a frequency, the second thing is we need to have a substrate. So, substrate we assume that we are using RT Duroid 5880.

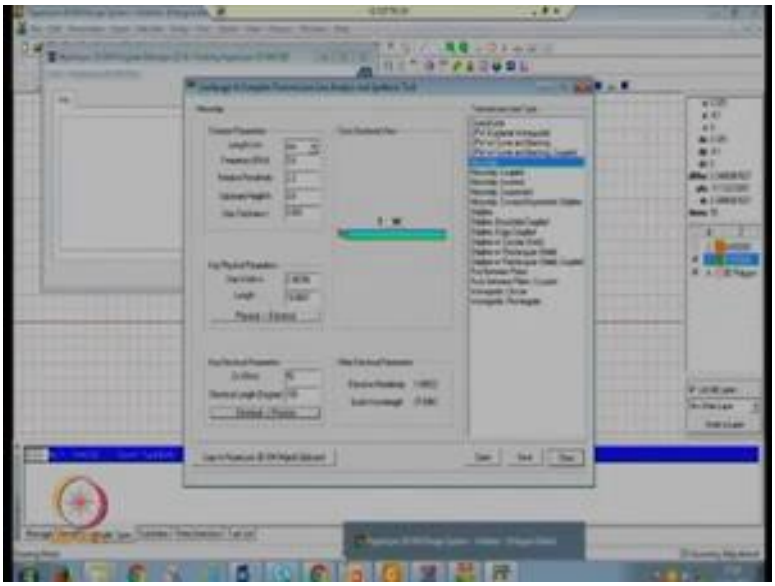
(Refer Slide Time: 13:08)




The specifications for RT Duroid 5880 are that epsilon r equals to 2.2, tan delta equals to 0.0012 and thickness is 0.8 and that substrate layer we have already defined.

We know from the convection theory of microstrip antenna is these are the equations which we used calculate the dimensions like L and W. Now we want to design right now we want to design the square MLA. So, these are the equations which we will use the frequency that we are using is 5.8 gigahertz. So, if you will calculate with the help of this equation you put in this equation, calculate W and then you calculate epsilon effective then you calculate delta L and after that you calculate this L, this L is a physical L that you will use when you will start designing various particular antenna.

(Refer Slide Time: 14:02)

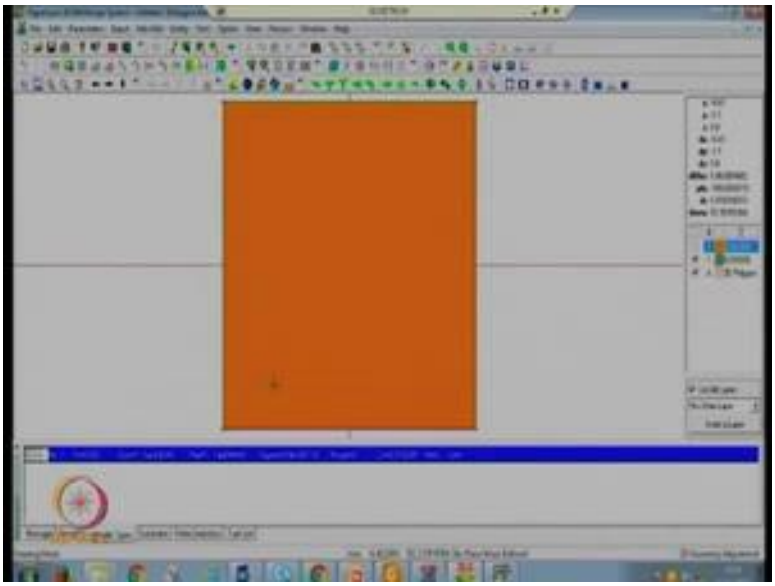


You can also calculate the length using the line gauge parameter as I told you earlier that with the help of line gauge you can calculate the different microstrip line parameters. So, all you need to do is just select the line gauge from the option of MGRID, like if you see here; here line gauge is given just open this, now if you see here there are different options like coaxial lines, coplanar wave guide, etcetera now. So, right now we are interested in microstrip.

We just select microstrip here you see different options are given you need to just give this specification and hence accordingly your effective L and W will be calculated. So, the frequency in at which that we are interested is 5.8 gigahertz and this is 2.2 relative (Refer Time: 14:51) of RT Duroid 5880 and the thickness that we were using is 0.8 and this is metal strip thickness. So, generally we take it either 0.002 or 0.004, just keep it as it is now we know for the substrate it inverts its phase from one end to another end. So, it should be around 1. So, electrical length should be 180 degree. So, if you calculate it will come around this. This is approximately same as the equation we calculated.

Now, if you see the calculated length was around 16.74 while in that with the help of line gauge it was around 80 and just roughly saying not exactly say, but rough idea you get from with the help of line gauge. So, let us start making the polygon go the MGRID.

(Refer Slide Time: 15:51)



Now, from here now, you see you go to entity part, select rectangle, now if you see here, you need to give the reference point; the centre point where you want to make your polygon. So, let us right now let us take it at centre. So, keep x coordinate at 0, y coordinate at 0 and we need to check at which layer E want to design. So, we need; we want to design our patch antenna over the substrate here. So, the z coordinate should be 0.8, but by default the layer selected was z equals to 00. So, let us select first this co ordinate now you design; now you can see here z coordinate is 0.8. So, it will depend which layer you select accordingly z coordinate will be shown here. So, the length should be 16.74 and the width should be 16.74 to design a square MSA, now if you see just click on all you can see the geometry this is my square polygon.

If you see here in this window, in green there is a dotted line. So, this dotted line; it shows that it has infinite conductivity and it is a ground plane. Now if you design anything on this particular layer then it will be like you are cutting a slot on infinite ground plane because by default it is a ground plane with infinite length and infinite width. So, if you are designing anything above that. So, it is equivalent to that you are cutting a particular slot in that particular thing. So, this is my rectangular MSA now you. So, far you have designed the rectangular MSA and the next thing is you need to excide to excide it we need to define a port. So, the length in this case is around 16.74. So, here we are not using any broadband technique. So, the approximate feed point location should be from L by sit to L by 4 just to give a start point.

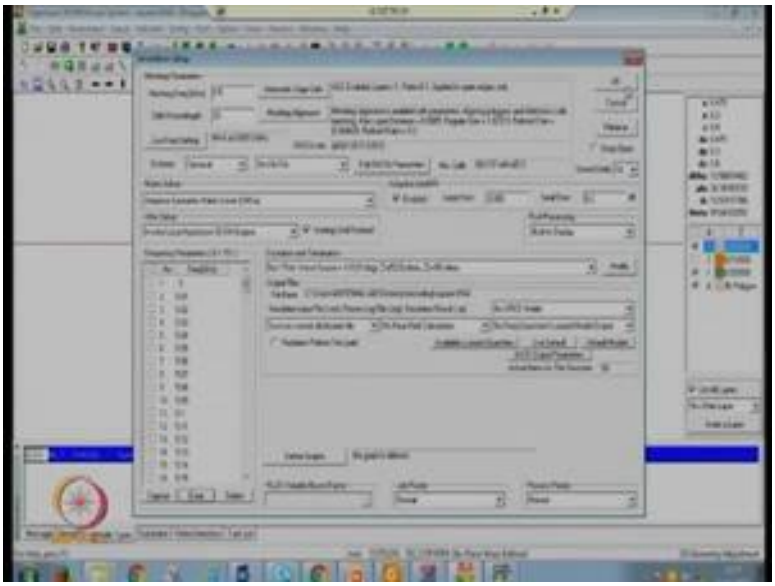
Let us take it around 2.5, select entity, go to probe feed to fetch then here you need to select the location where you want to provide your feed. So, this is 2.5, now y coordinate, I want to keep as it is; this is the number of segments because you are defining probe feed that will be in the form of cylinder and the cylinder will be decided in the terms of circuit. So, the number of segments the finer the more the number of segments the finer would be the circuit.

Let us take it 12 then this is a start z coordinate and these are this will show you the layers in between you want to connect your conductor. So, this should be 0 and 0.8 because 0 is my ground plane and at 0.8 we have a patch. So, my conductor should be connected between these 2 layers and in this case, the negative level should be defined at the ground level. So, it should be 0 and we need to define in between some positive levels. So, by default it is 0.08. So, we need to just take it above the ground plane. So, we may keep it as a 0.08 or we may keep it like 0.01 that should be enough.

Here we are providing a coaxial field. So, in this case, since we are dealing with C band for this particular antennas 5.8 gigahertz, so we will use SMA type of connector and the radius of SMA type of connector is 0.6 mm. So, let us give it 0.6 mm, portrait, sorry I could not enable this particular thing, select then you select this and delete then again entity, probe feed to patch, last time I did not enter here. So, that is why my feed location was at centre. So, if I entered then this is my center position, this is 12 number of segments starts at coordinative 0 ends at coordinated 0.8 and negative level is 0, positive level is 0.01 around and this should be 0.6 then press ok.

Now, if you see, this is my feed point location, now we need to simulate it, before simulation we need to save it. So, let us first save it let us save it, square MSA, this is we have saved.

(Refer Slide Time: 20:54)



Now, we have to simulate it. So, then go to process you see, here we have simulate option start simulation, now if you see here we have different options the first is meshing frequency, this frequency should be higher than the R operating frequency. So, in our case we are designing it for 5.8 gigahertz. So, let us take it around 6.5 gigahertz. So, larger will be the frequency, finer would be the meshing, but the time will increase. So, it is generally desirable that whatever is meeting your requirement like 6.5 would be would suffice for our case. So, that is why I have taken 6.5.

Now, the second option is automatic edge cell, now if you see here, automatic edge cell means that it is providing you a meshed structure and the meshing towards the edges will be finer which will increase the accuracy of the our results. So, we need to enable it, we check here now if you see the frequency we defined that is given here, this is second option is cells per wavelength. So, this is the; how many cells we are dividing per wavelength that information is given and the low frequency part that I have already told you, now if you see here a is the layer that is not enabled, here no is written.

To enable it you need to make it 1, there are different options you can see here, depending upon the accuracy we need to select the options now for like basic antennas or 3 dB coupler, this 1 is now if you want to design a high accuracy coupler then you need to select the layer 2 or the higher versions so, but for antennas the 1 is, so just press if we have C, it is showing us the details corresponding to the machine part. So, the number of

cells with automatic edge cell and the minimum surface cells, these type of information is given here you need to do anything else here you, just press ok.

You see here type, this is you see here the scheme is given that I have already it is a some type of scheme, the next is adoptive SMSA, this is a scheme which runs in the big ground of this particular software. So, this is a, this uses multiple we see use for to simulate the antennas. The next part is we need to define the frequency. Here let us take it from 5, start give the start frequency then end frequency and the number of frequency points. So, just you need to give the sufficient frequency points. So, that it should be able to calculate results properly by picking the frequency points let us take 151, you can see corresponding to this, all the frequency points are given.

One more thing I want to say adoptive (Refer Time: 23:33) it is given here, now if you see here, if you enable if you check this particular option it will pick some frequency points from this particular range and then calculate the corresponding fields and then extra collate your data and then show you the results. If you enable this particular option it will give you good accuracy with relatively less strain, but if you disable this particular option then it will calculate at all the frequency points and your simulation time will increase. So, this is how you will proceed.

In this lecture firstly, we discussed about different types of software and then we moved ahead towards IE3D program manager and then we designed basic micro step antenna array and then we made the polygon. In the next lecture, we will discuss about the post processing parameters like current, S parameter, VSWR and gain, directivity, efficiency and such types of parameters.

Thank you for (Refer Time: 24:41).