Fundamentals of Power Electronics
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Lecture - 70
Forward converter design mfile

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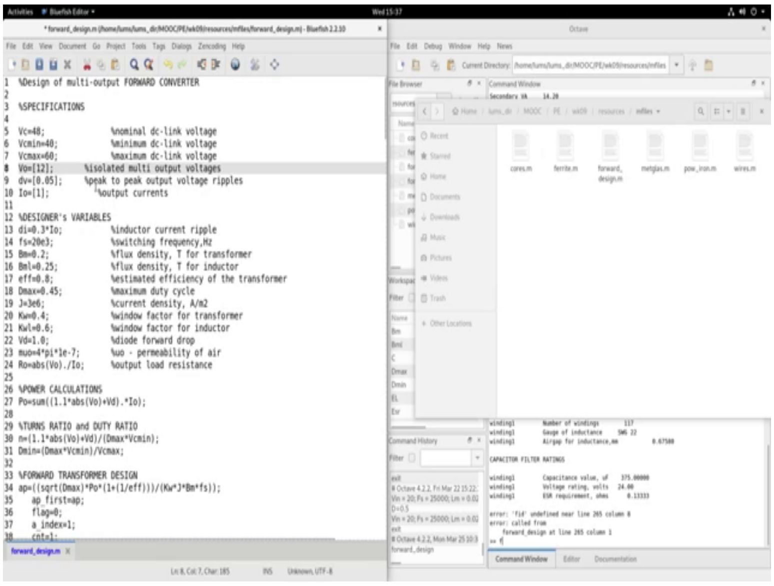

Now here I am going to show you an m file wherein I have designed a forward converter. Recall that in the last week resource I had included a forward converter design example, now I am extending that to include inductor design with the core and also the transformer design with the core.

So, for that some extra files are needed I have included cores dot m, ferrite dot m which gives you the data for the ferrite cores like the pot cores ee cores and so on. I have included some for metglas cores, powdered iron cores I have also included the wire table here.

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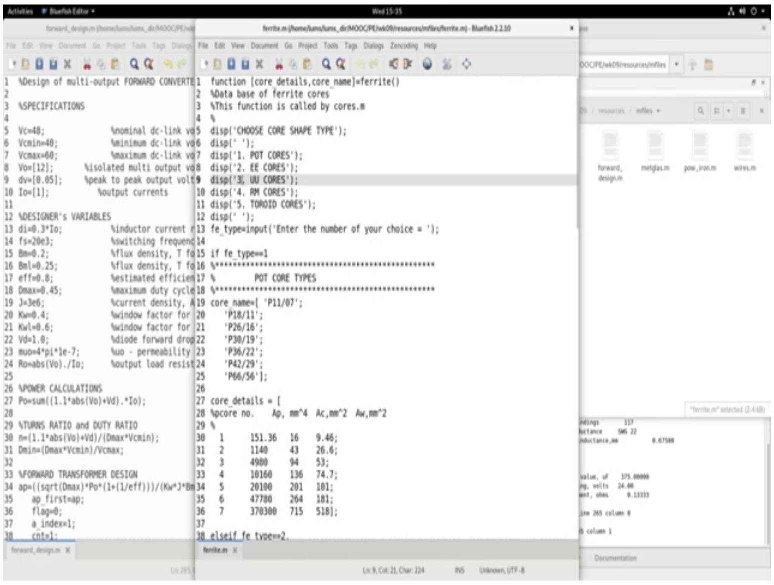

Just to show you, if I go into ferrite dot m you see here POT CORES, EE CORES, UU CORES, RM CORES, TOROID CORES. These are the various varieties that I have included.

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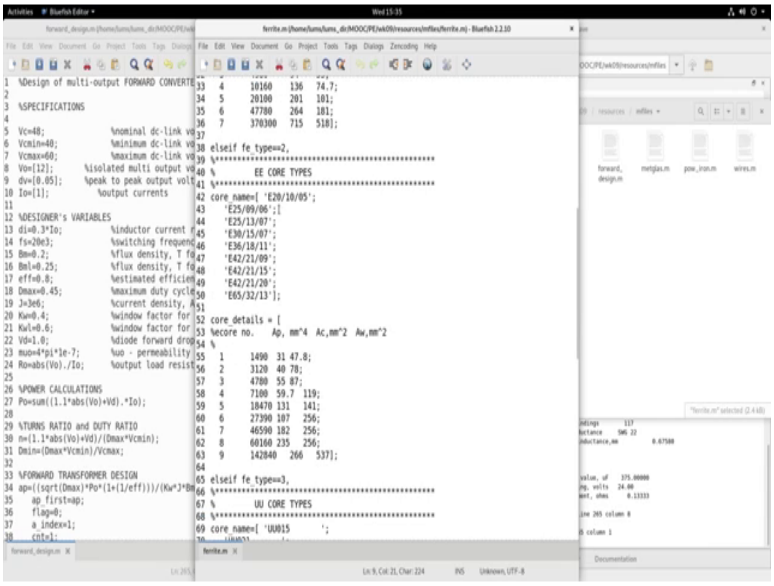

And I have put in the database Ap that is the Area product, Ac the core Cross section Area, window area in into in the form of matrices and I have also included the strings and for all these cores.

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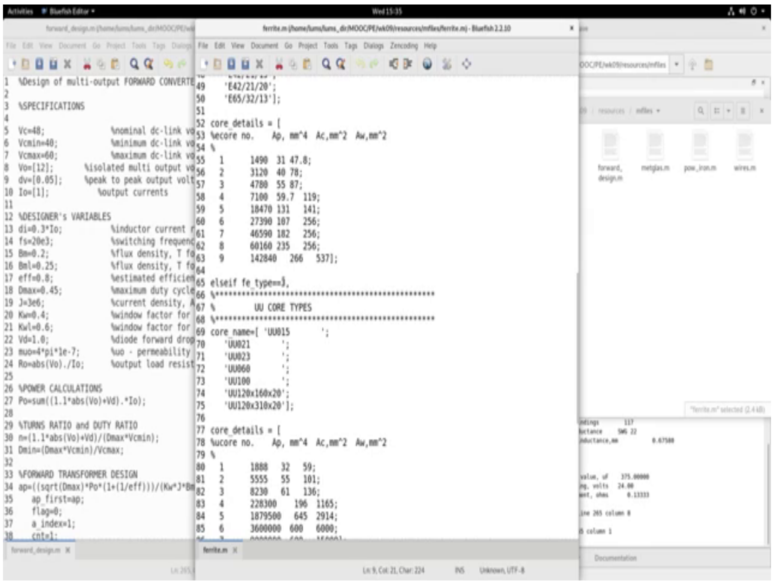

It is simple for you to add as much as you want into this database.

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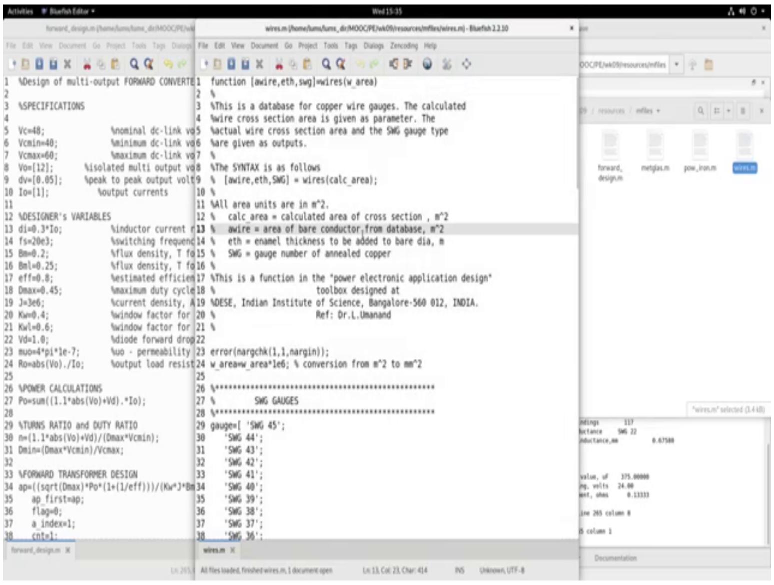

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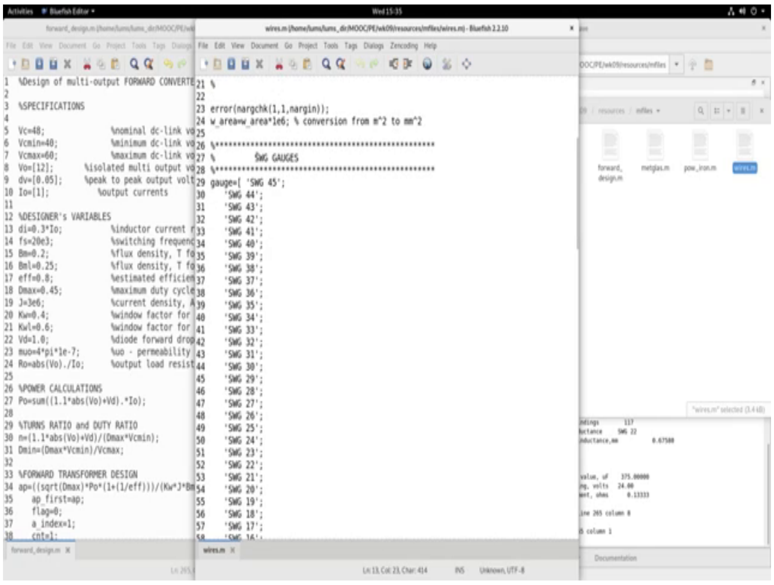

And then you say, in the wires table I am going to show you that I have included the standard wire gauges details, these are the standard wire gauges starting going down from SWG 45 number toward SWG 7.

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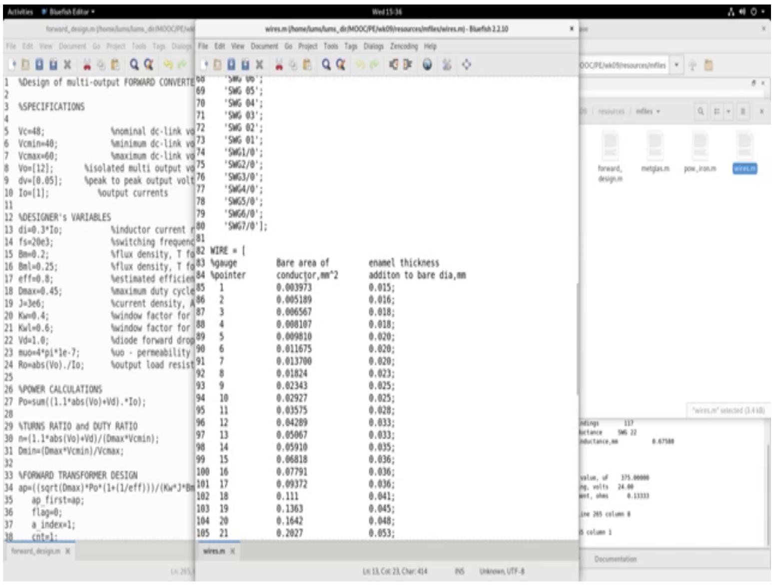

With all their bare conductor area and enamel thickness, all these things.

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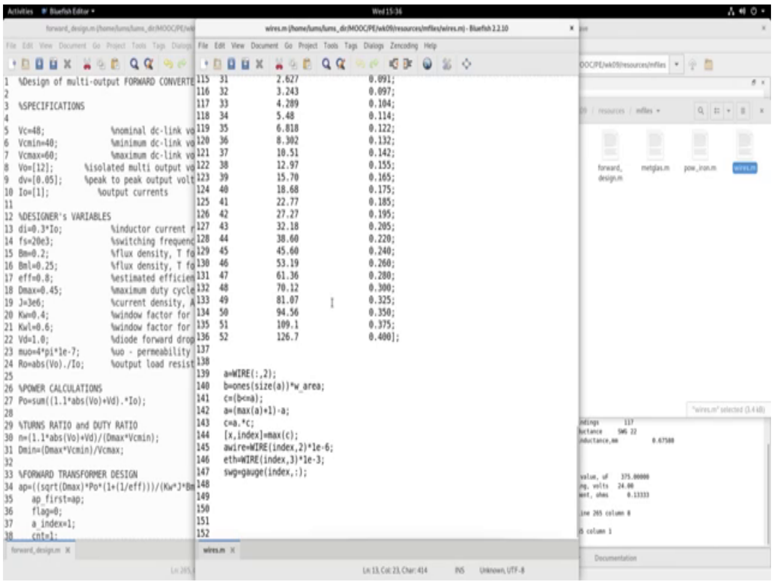

So, you have the wire gauge table and also the cores table and in forward design dot m I have included the actual design calculations. So, what is there in forward design? Look at it first the specifications, we saw the specifications we see 48, we see minimum, we see maximum calculation, you can calculate it if you have tolerance otherwise list the minimum and the maximum

Now, the change that I have done, V naught is indicated as a vector twelve volts and dv as another vector the delta v and I naught is also a vector one volte these are single a single secondary, but if you have multi secondary you just have to include comma and put in let us say, you can put in a 15 volts, you can put in a minus 15 volts so on. And accordingly the ripple for the output corresponding that vector will change and the I naught vector also will change, but now I will just bring it back into a single. So, this can be used for multi output forward converter.

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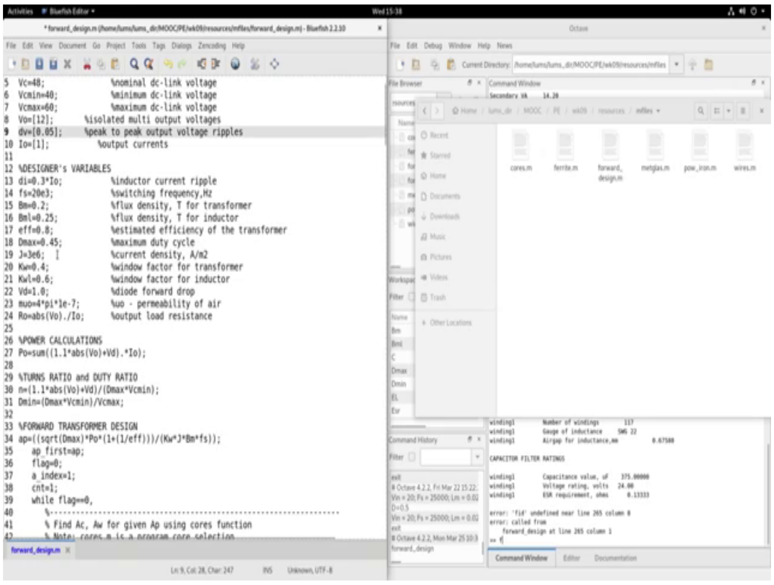

Then the designer variables delta I, I have set it at 30 percent ripple inductor current ripple can change it did that so that to reduce the core size. 20 colour switching frequency, I have given two different flux densities; one for the flux density or transformer where I am setting it as 0.2 tesla, another Bml the flux density for inductors as 0.25 tesla.

The efficiency of the transformer worst case minimum is 80 percent generally, when you design it will be much more than 80 percent. So, this is a safe lower limit to calculate the input power. Dmax are set at 0.45, J is 3 ampere mm 3 ampere mm square or 3 into ten to the power of 6 ampere meter square, Kw 0.44, transformer 0.6 for inductor, Vd and all these other calculations.

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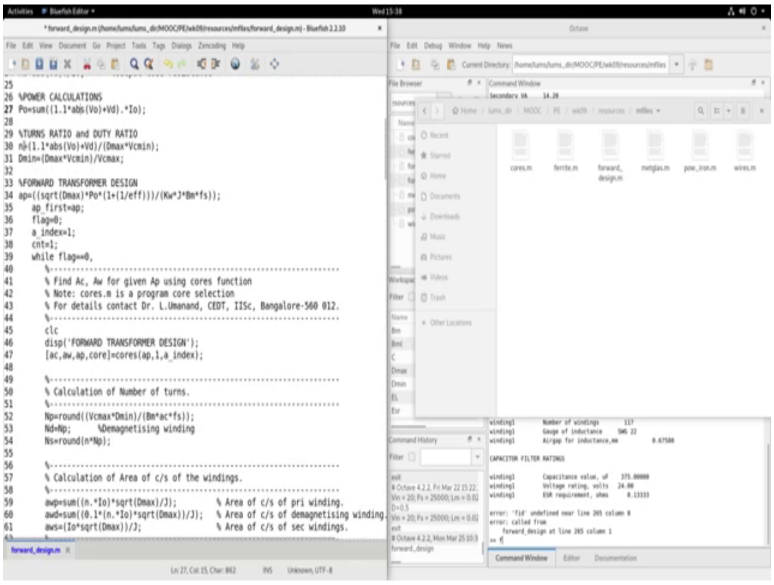

You see first the power calculation P naught is 1.1 times V naught plus Vd into I naught and summing it over all the windings sigma. TURNS RATIO; find out the TURNS RATIO, you have 1.1 times V naught plus Vd of divided by Dmax Vc min or V min Vc max which will give you n of all the all the secondaries with respect to the primary n is a vector because I have I have used MATLABs vectorization strength.

Then the FORWARD TRANSFORMER DESIGN or this is where the new thing comes in, find the ap; ap using the equations and then going to the while loop you call the cores function the cores function which I have indicated here and that will go into the cores function and try to search for cores. So, it will ask which core you want whether you want to have ferrite core, MATLAB metglas different core materials. And once you choose the material it will go into that and then choose the specific core according to the area product calculator.

Then it will give out the core selected core, the selected cores ac selected cores window area and the area product.

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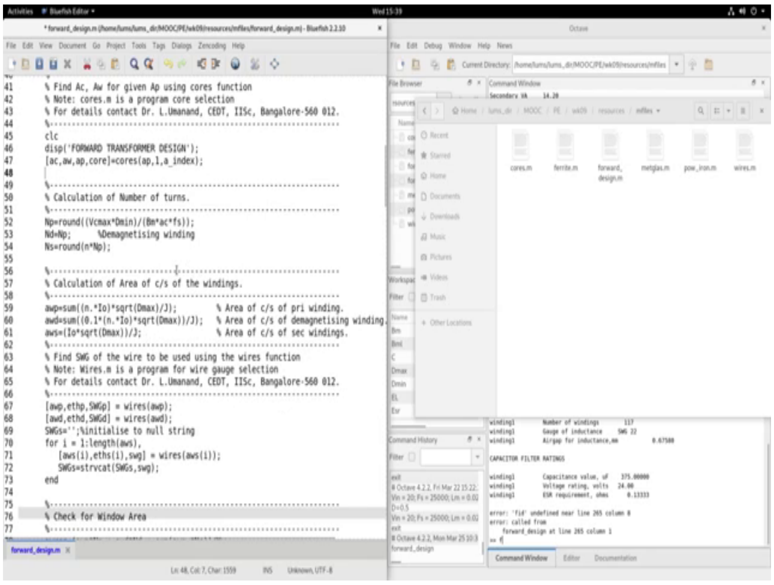

And using that Np, Nd, Ns are calculated and then you are calculating the wire gauges here and for that I am using the wires using the wires table and the wires table will give you the aw wire cross section actual for the wires and the and the SWG, Standard Wire Gauge.

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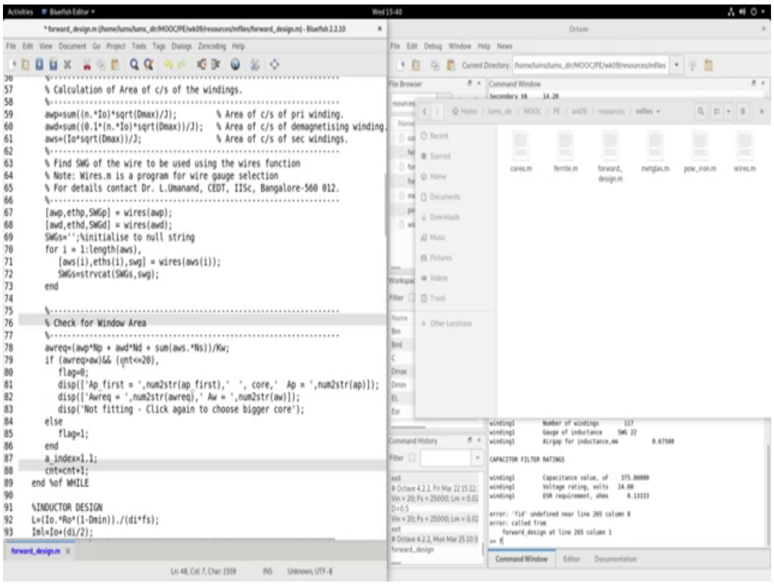

Then you do the window area check if it is not fitting it will go into the next loop it will ask you which again to choose a core and so on.

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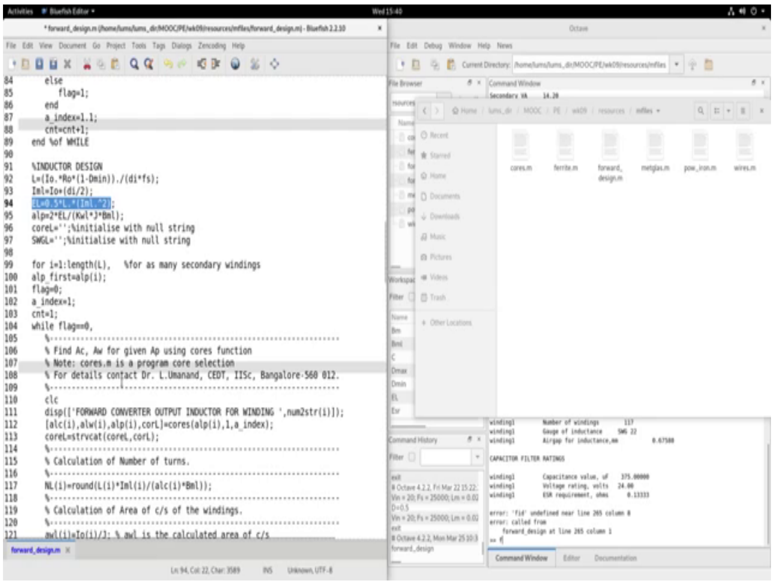

And then the INDUCTOR DESIGN comes in finding out the value of L for every secondary you have an inductor. So, L here will be a vector and find out the energy of the inductor and finally, you do a area product design just like we discussed.

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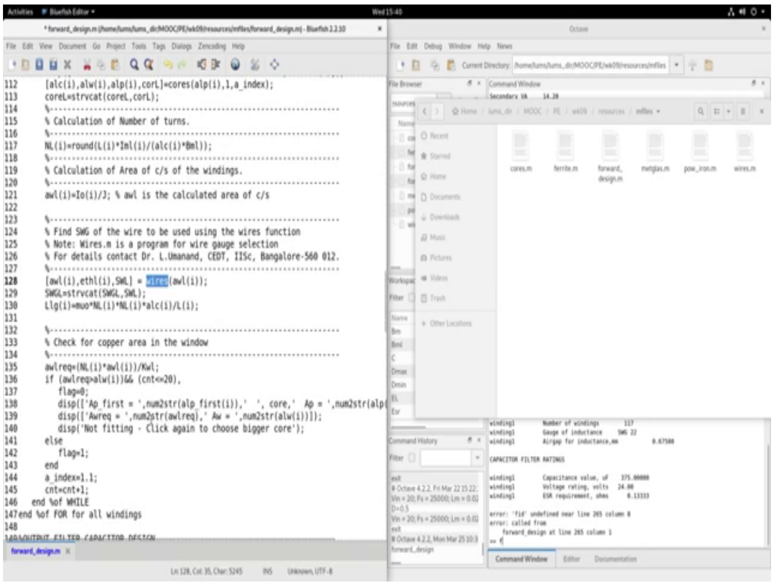

And do the core you I am using cores here again, to select the cores and then wires here to select the wire gauge for the inductor and only here you also calculate the air gap and goes into an iteration.

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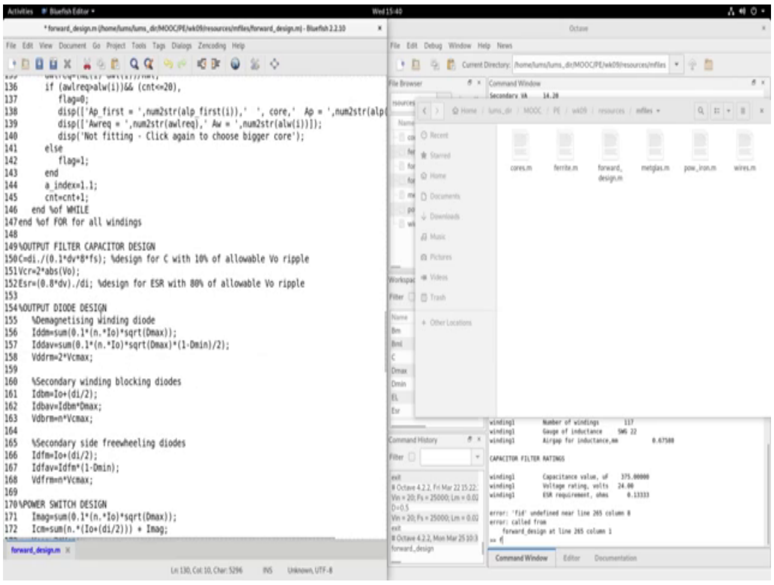

If it is not fitting and then the OUTPUT CAPACITOR FILTER DESIGN; the OUTPUT FILTER CAPACITOR DESIGN, the DIODE DESIGNS. The various diodes demagnetising diode, the secondary blocking diode in the secondary freewheeling diode POWER SWITCH all those things.

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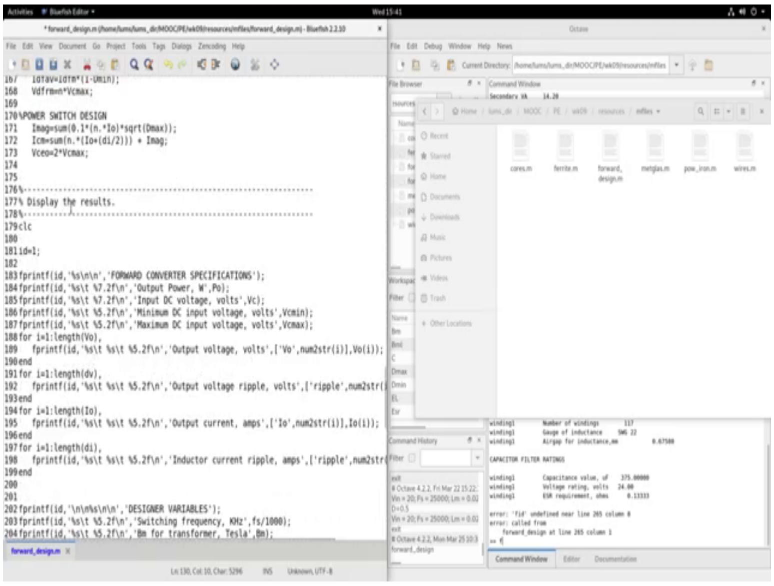

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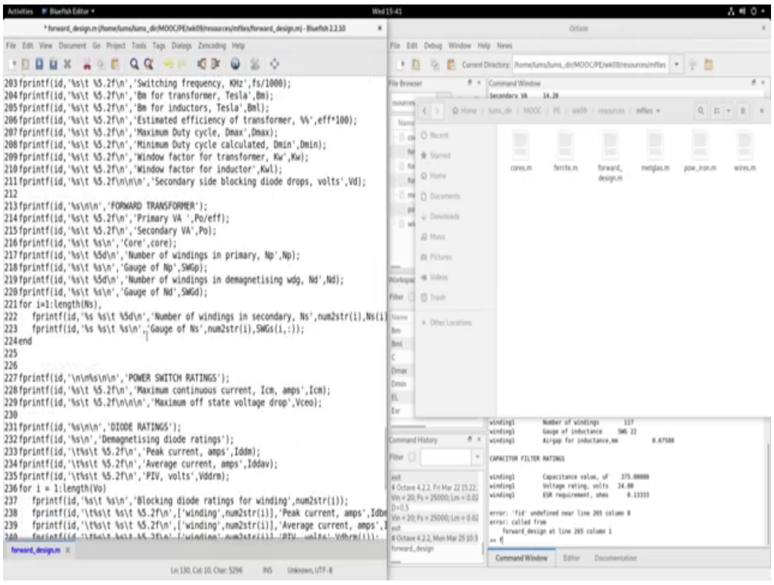

Then comes the display section where you display all the area details. So, let me just run this for you for this specification.

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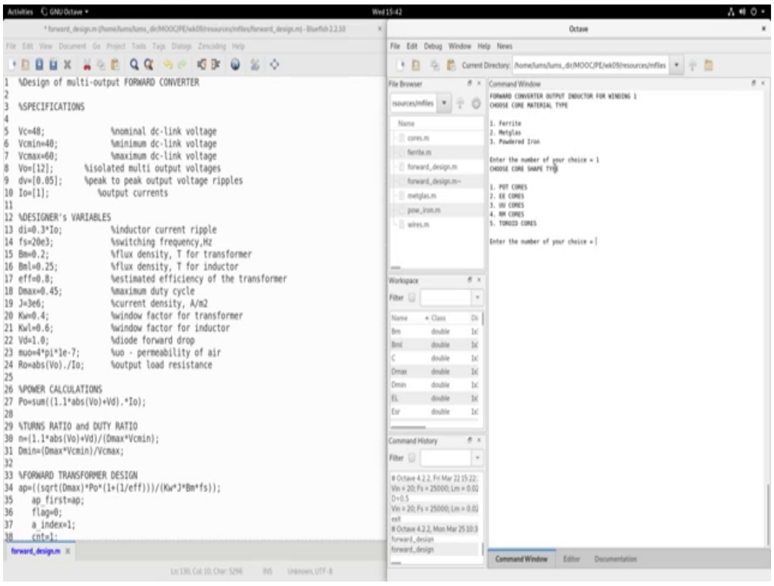

So, I will go into octave I am already in that folder you see that you see forward design and the other m files

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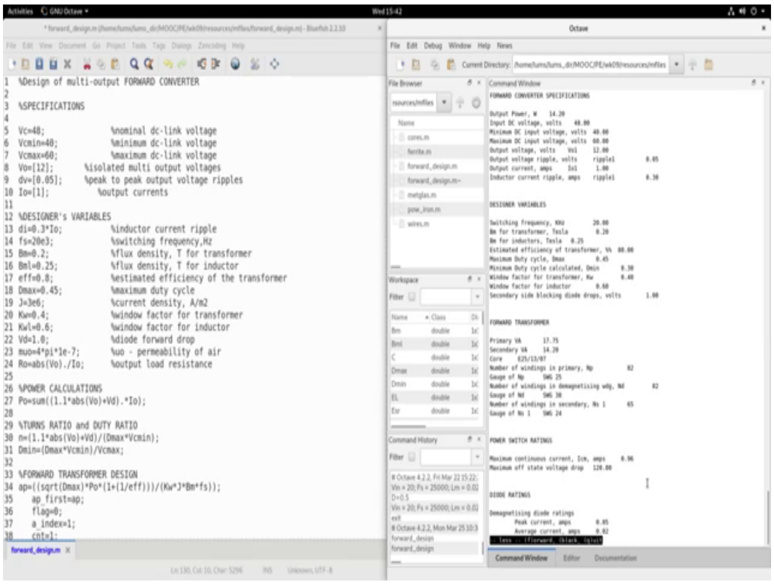

So, let me type in forward convert FORWARD DESIGN and then you execute that it will ask you to choose a core material, I will choose Ferrite which is 1. I will choose ferrite and then within ferrite it will ask you to choose POT CORES, EE CORES this is the data which I have entered. A minimal set of data you can always increase it you can add your own set of new cores and cores shapes.

Let me choose EE CORE now, second and then see that it may then it is asking for the INDUCTORS and I will again choose this one again EE CORE. And that is it the design is done and it will get printed you see the specifications and the DESIGN VARIABLES, FORWARD TRANSFORMER see, choice of E25 13 0 7, the primary windings, the Gauges, Demagnetizing Winding Gauge so on, the POWER RATING of the switch.

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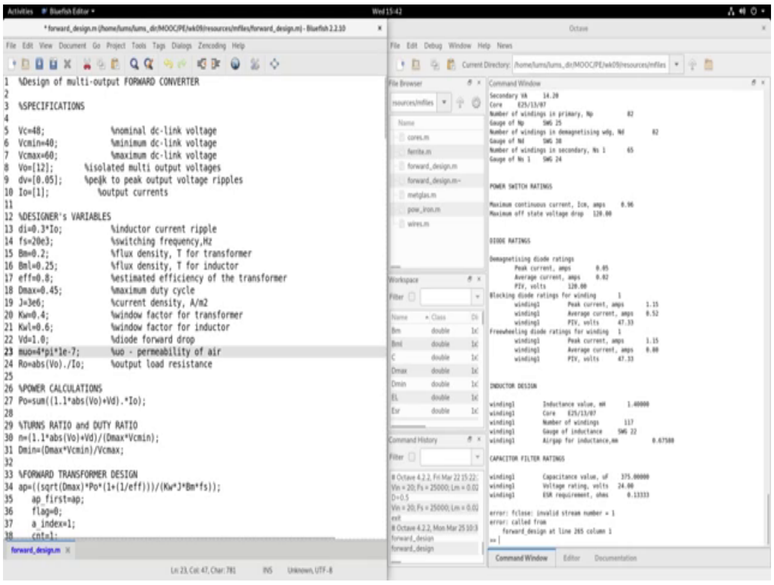

And the DIODE RATINGS, Demagnetizing, Blocking, Freewheeling, INDUCTOR DESIGN all these things are calculated and you see the output. I will allow you to explore this and leave it to you fine tune it and try to understand this forward design m file.