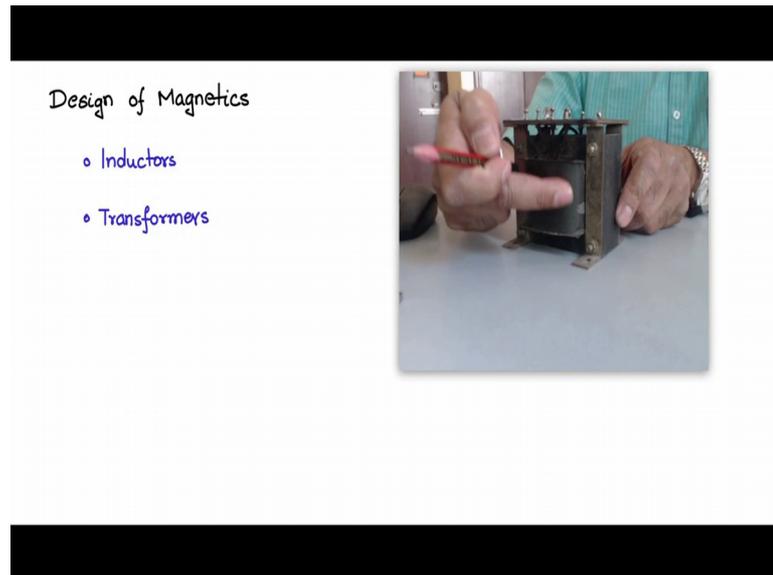


Fundamentals of Power Electronics
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Lecture - 61
Magnetics Design Intro

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In this session we will discuss one of the most important aspects in switch mode converters and that is design of magnetics. Earlier in the rectifier portion of our discussion we discussed power supply where, the main voltage is stepped down by using a transformer and transformer can act as isolation and inter surge limiter. So, we saw a transformer come in there in a symbolic fashion in the circuit. How do we make such a transformer? How do we fabricate that?

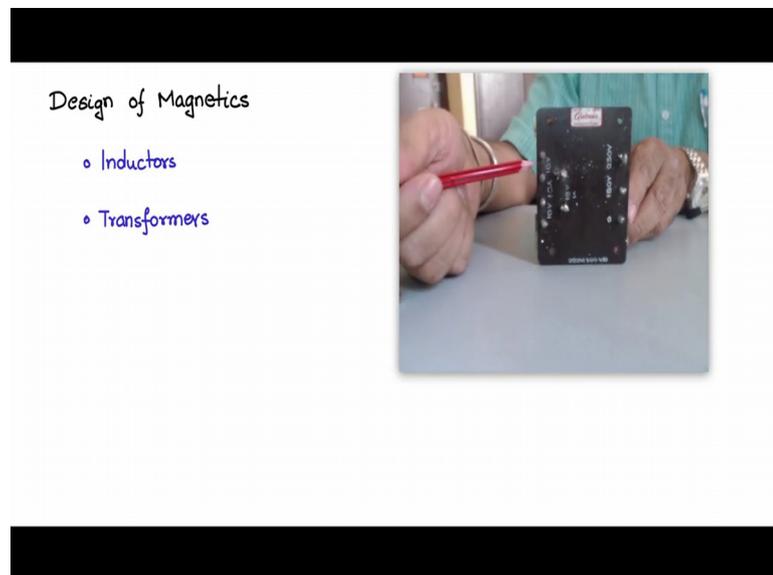
Later when we discussed the non isolated converters, that is the primary the buck boost and the buck boost there was a magnetic component that came in all this convert and that is the inductor. We used the inductor symbolically and calculated its value, but how do you physically realize it such that you obtain that calculated or the designed value such that it gives you a designed value of I as we required. So, how to design such inductors?

Then later we discussed isolated converters like the fly back converters and the forward converter and both these converters had inductors as well as transformer isolation. So, how to design the magnetic, some of these transformers and inductors which will give

you the desired electrical effect? So, this is the aspect of the discussion that we will be carrying forth now, so that we will be able to design inductors and transformers for our converters, but the focus of the class in this session is design of magnetics.

I have here a transformer. You can see this is a low frequency transformer and these are laminations, this is coal rolled silicon grain oriented steel, silicon steel and you see the former here and on the former the winding, the winding is done and then after that it is insulated you will be able to see windings coming out and then terminating on to the terminals on top.

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So, if I show it in this direction, you will see you will see the terminations marked. See here you have 0 to 230, this is the 180 tab, it is 230 and on the secondary side you have the 18 volt and 18 volt this 2 and then there is another tap here. So, this is transformer that we normally use for stepping down, stepping down and using it along with here.

You will you will connect it with rectifier capacitor filter and then the linear ICs to get the 15 volt plus minus 15 volt supplies. So, this is that type of a transformer 50 hertz transformer. Directly from 50 hertz to 30 volts means this is another transformer.

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Design of Magnetics

- Inductors
- Transformers

A photograph showing a person's hands winding a copper wire onto a small, dark, U-shaped ferrite core. The person is wearing a light blue shirt. The core is placed on a white surface. A red pen is visible in the background.

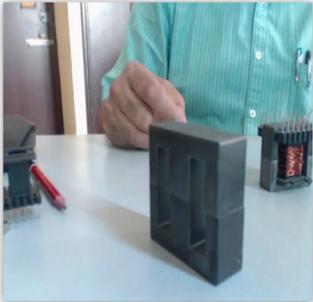
This is made of ferrites. I will just remove this, this is IEE core. The shape is like E and therefore, it is called EE core this is the ferrite material and I will remove that there are two EE cores. This is the former and on the former you make the winding the former will be something like that. I have this, this is an empty former and on the former you will be winding the copper.

And the wound one will be something like that. You will insert it into the EE core like this and then take the other half of the core and then place it.

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Design of Magnetics

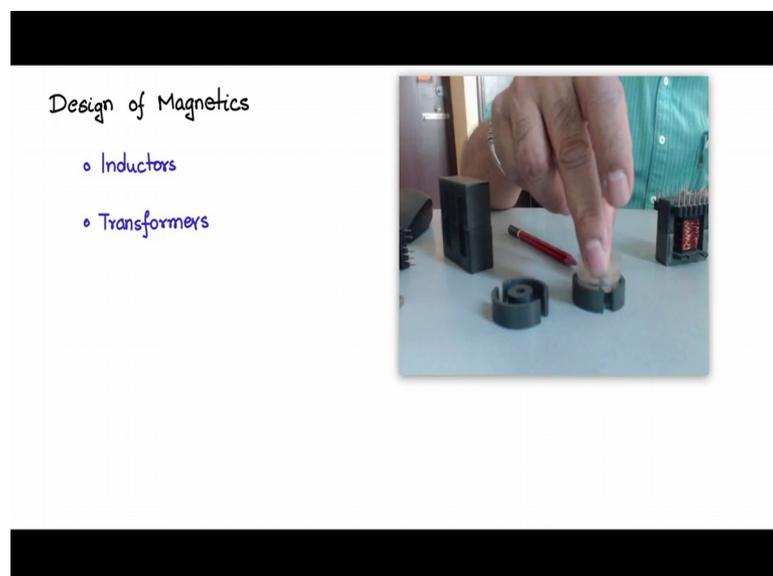
- Inductors
- Transformers

A photograph showing a person's hands assembling an EE core. The person is wearing a light blue shirt. The core is a dark, rectangular block with a central cutout. A red pen is visible in the background.

So, this will be another transformer or an inductor whether transformer inductor I will tell you later how to do that, but the core will be still the same. So, this is a ferrite based EE core high frequency transformer or inductor. This is another bigger size EE core where you have again two half's and makes a makes up the complete EE core and this can be used for either transformer or inductor.

And we will discuss how to go about doing the design. You will get various sizes of this type of EE cores, but there are many many shapes not only EE. You have UU cores course, you have pot cores. I will show you an example of a pot core.

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You see this is a pot core. It is totally enclosed best for electromagnet interferences where it rejects all enter electromagnetic interference going out and coming in and it has two halves replace them like that there is a former here to see. This former it has a multi section; you get single section former multi section former you can have the primary, secondary one secondary two like that and then, wind it and then place it into this and these cores can also be used as high frequency transformers or high frequency inductors.

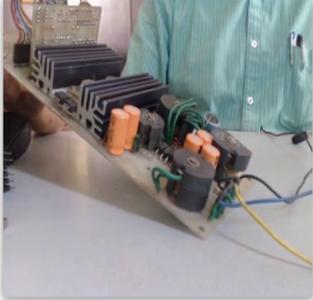
So, like this there are various shapes. You have RM cores and very many other shapes even in the EE cores. With circular section the central section can be circular. So, all those possibilities are there. Look at the data sheets the Siemens, the Siemens cores are pretty popular. Look at the Siemens core data sheets to understand the different types of

shapes and materials that are available. These are all ferrites on the high frequency side. We normally use ferrites on the low frequency side. We use the CRGO laminations.

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Design of Magnetics

- Inductors
- Transformers

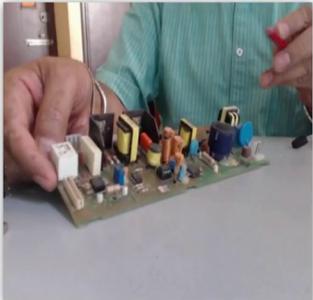


This is a power supply board and you see of course there are the power switches mounted on the heat sinks. I want to bring here focus on to these components here; these are the pot cores in this particular power supply board. There I have used the pot cores for inductors and transformers high frequency switching at 50 kilohertz. So, this is how it will get integrated into the PCB.

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Design of Magnetics

- Inductors
- Transformers



Another example of the PCB you see this, these are high frequency again ferrite EE cores, this is EE core, there is another EE core here. So, both transformers and inductors are done here in this board with EE cores. So, you see there are different cores, different core materials, different core shapes, different core types, different frequencies for which you can operate. You have ferrites, you have silicon steel, you have permalloy, you have amorphous materials like metal glass, amorphous glass powder, etc. Many materials have different magnetic properties. So, different shapes and sizes all these are available in the market which you can effectively use for making these inductors and transformers.

So, I have given you an idea of how it looks like and where it will be used and how it is used just to give you a visualization. And, now we will go into these inductors and transformers in detail and see the equations leading to fabricating these inductors, such that you get an electrical effect as we required.