Fundamentals of Power Electronics
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Lecture – 53
Simulating the primary converters

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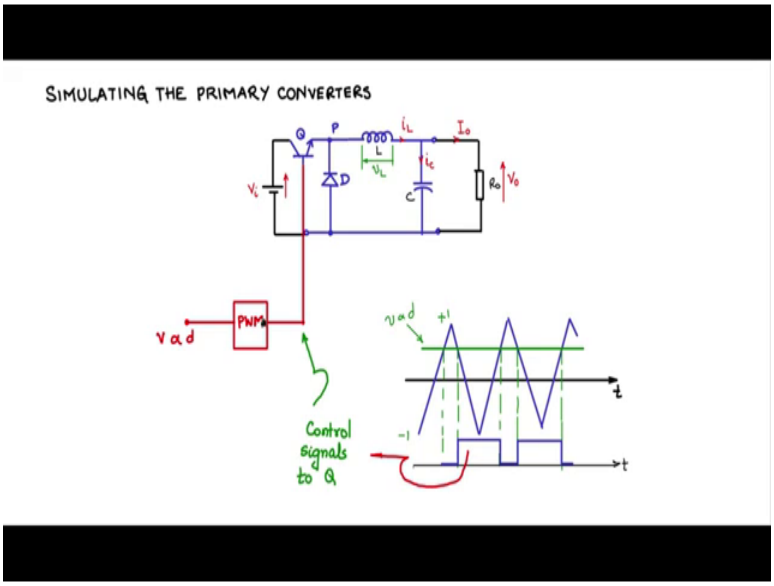

Let us now see how we will simulate the primary converters. I will supply in the resource potion of the course website, the simulation files for the buck the boost and the buck boost converters. Here what we have; we have discussed everything about the primary converters accept that how to give the information signals the gate pulse signal to the controlled switch. So, what I have done here is that I have passed it; I am passing it through a PWM generator block during simulation and giving a voltages which is proportional to do recycle.

So, if I want lower duty cycle, I will decrease the voltage; higher duty cycle, I will increase the voltage and this will compare with the triangle waveform to generate the PWM and pc signals will turn on this BJT. So, inside this PWM block what you may find is that there is a triangular career. So, this is let us say 10 kilo hertz; I will set it 10 kilo hertz for now, but you can experiment with different frequencies and this carrier is swinging from minus 1 to plus 1 and then you can have a control voltage a voltage is proportional to duty cycle. And then you will see that after comparison of these two voltage signal the output that you will get will be something like this.

So, let us say all the at the comparison point you will see that the voltage proportional to control voltage upon duty cycle is higher. So, let us say we will have high there and then here the control voltage is lower than the triangle and its higher than the triangle so on. So, as this control voltage moves up and down, you will see a modulation here happening in the pulses and these are pulses that will be given to the control will be used as control signals for Q and this is what you will be seeing at these point. Later on I will discuss in detail what goes into making the PWM so that you can build other PWM blocks and techniques.

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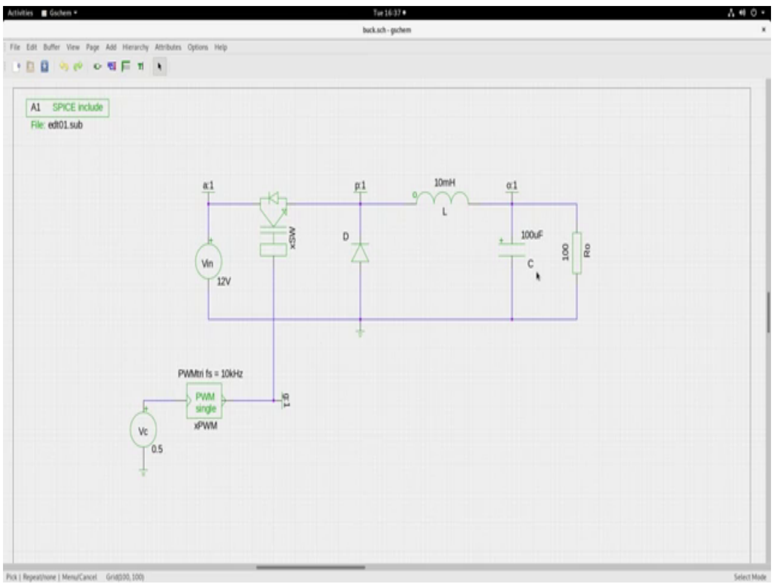

Let me now show you some simulation examples. In the resources folder I have three folders; one on buck converter, one boost converter and another on the buck boost converter. And within them I have the schematic files, net list files in this ar files along with the edt 01 dot sub. This is subroutine sub circuit file. Now when I open the schematic file, you will see something like that buck dot sch and this is the circuit. So, you see that I have here a switch a semiconductor switch controlled semiconductors switch like a BJT or MJBT. It is a generic switch a Vin a diode here L inductor capacitor and or not and see here that I have a PWM module which is basically V in a diode here L; inductor capacitor and r naught and see here I have a PWM module which is basically built of a triangle wave form and I have a source here to represent the voltage proportional to duty cycle.

So, I have set it at 0.5. So, 0.5 in range of minus 1 to plus 1 approximately it is now 75 percent duty cycle. So, let us see how the circuit simulates. I have put various node points; I have node point here for the input a node point, here for the pole node point for the output and node point for the gate voltage. So, to simulate let us go to the command line; command terminal.

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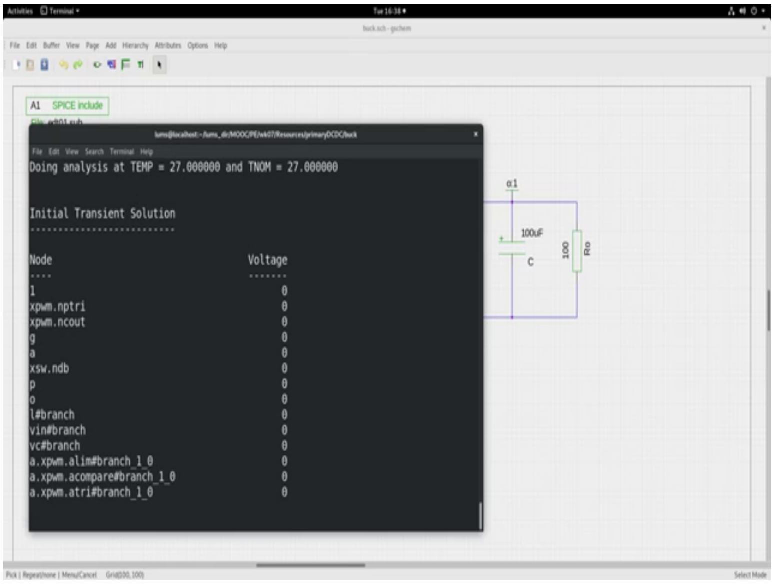

I have opened the command terminal and here we will run the simulation. I will run, I will use this and run buck. So, it will create the netlist and then run the simulation and show the waveforms. Now what are the waveform that I have here?

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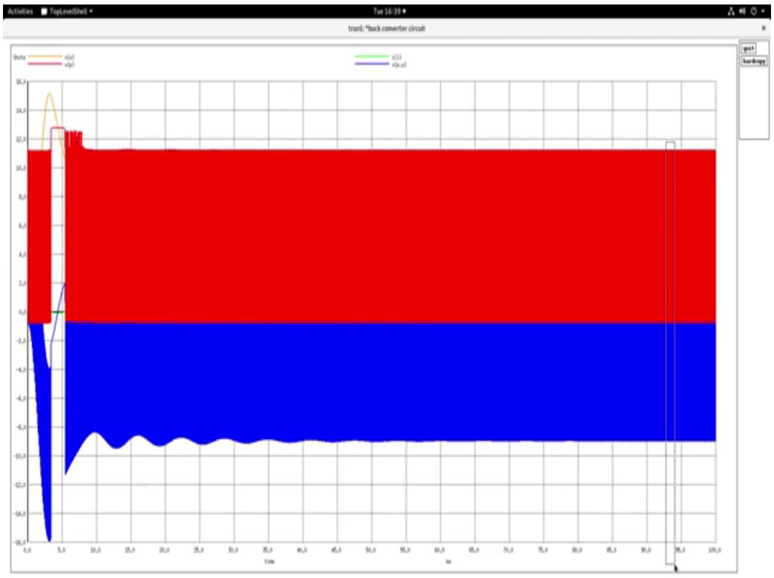

I will indicate to you before that let me open the puck dot cir circuit. So, apart from the dot run statement and includes statement, I have the control statements where the background of the figure windows is said to y foreground is black and then plotting the pole voltage; pole the output voltage that is the inductor voltage output voltage and the inductor current.

These are the things that are being plotted. So, now, back again to the plot, you will see that the plot goes through tanget phase here and then starts to reach the steady state. So, you would like to look at the steady state waveform. So, you can right click on the mouse and drag a very small portion on the steady state portion so that you will be able to see that portion only.

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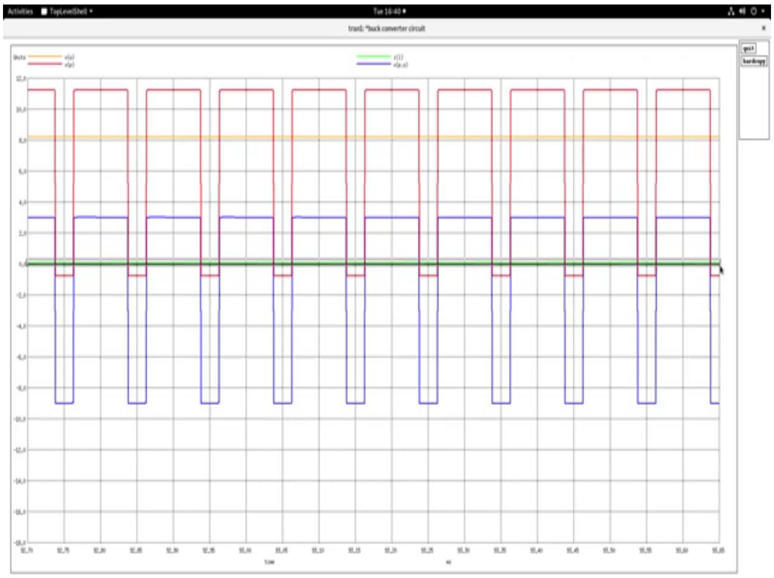

So zoom that up. So, this is the steady state portion and you have green color is the i L waveform pole to output is the inductor waveform pole voltage waveform, V naught waveform. So, you can study them in detail here take for example, the green colored il wave form very small here if you want to see you can right click here and then amplify them by taking a zoomed small portion of that. It will zoom in and you will see that the inductor current wave shape as we had drawn while discussing the buck converter.

So, I will leave it you to explore change value change duty cycle, change frequency change the values of the lcs and explore inside out and try it out and try to learn about the buck converter. In a similar manner I also have the boost converter circuit schematic here. So, observe the boost converter circuit, you have the switch here the inductor on the input side diode here and similarly I have the node labels here, you can also look at the inductor current likewise I am having a control signal generation based on assign based on a voltage triangle comparison principal. So, this let us simulate, we will go to the terminal window and in the terminal window let us run the simulation for the boost converter schematic circuit. It will generate the net list, it will run execute. There will be a portion of dynamics and then reaches the steady state.

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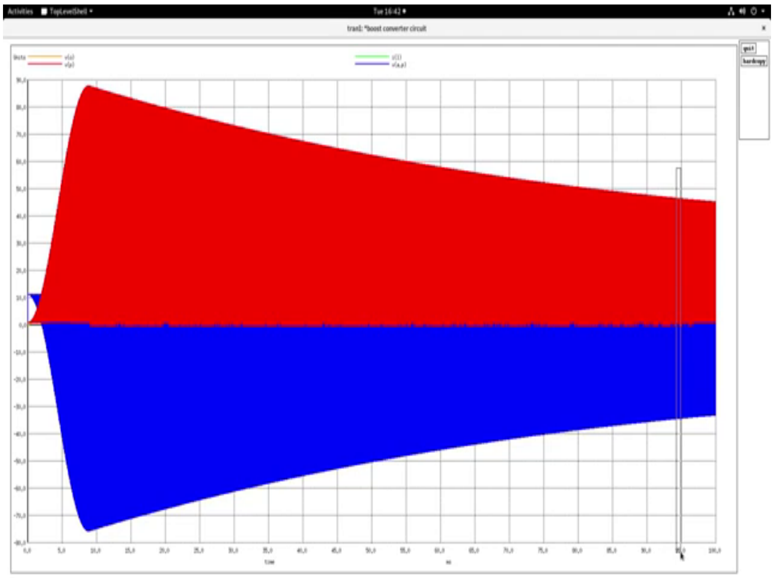

So, what you could do is right click near the steady state. This has still not reached the steady state, but anyway you can observe. So, take a small portion out of that.

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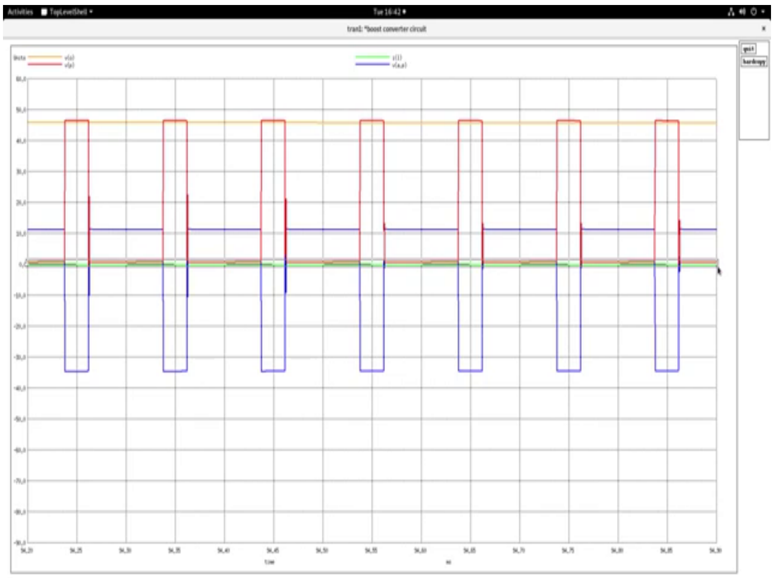

And you will be able to see it much better, green is the inductor current you could probably have a look at the inductor current by zooming in like this.

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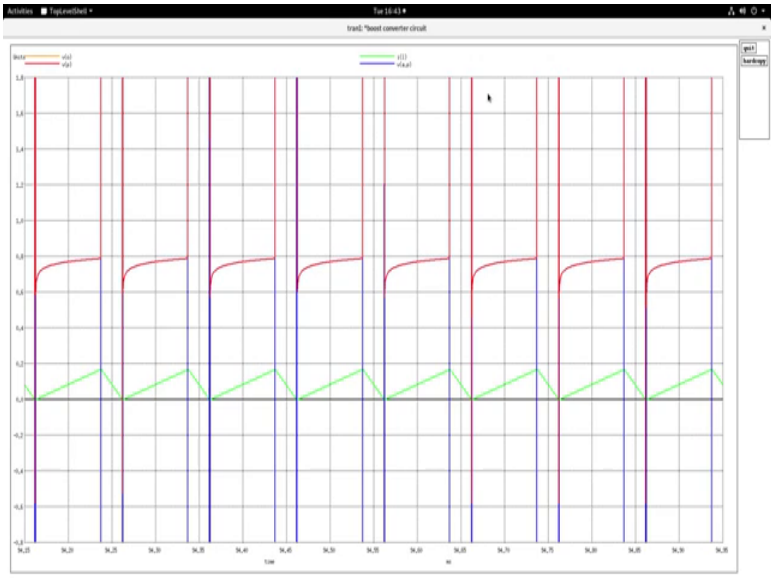

So, it is just at the boundary of discontinuous conduction the waveform as expected. So, you can study this further, get greater inside by playing with the values and understand the boost converter. In a similar manner I am going to show you the buck boost converter schematic.

So, the buck boost converter schematic is like this, you see the throw one to pole is BJT or an IJBT as you may consider fit and throw two to pole you have this diode D. Look at the placement of the capacitance of course, this is p's pi symbol showing plus here, but you will get a negative voltage the buck boost will give you a negative voltage for as we had discussed.

So, let us stimulate this PWM portion is like I had told for the other two converts, you generate the pulses by giving a voltage here proportional to duty cycle. Let us go to the terminal and let us run the simulation for the buck boost. It will generate the net list and the waveforms.

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And you will see that the steady state is around the right side. Let me take a small portion of that right click and drag an area and you will get a zoom portion of that and this will give you a much better detail.

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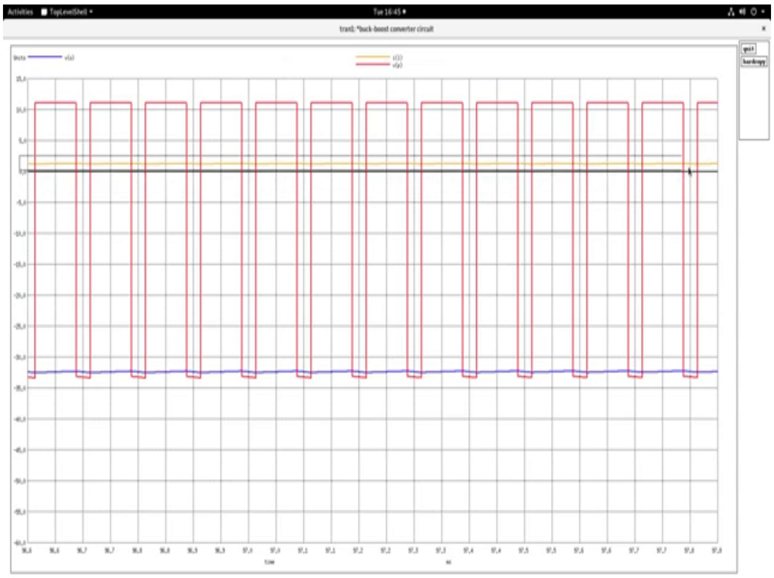

So, observe that output voltage the blue line here negative; it is in the negative side. Change the duty cycle observe that, observe the values, observe the various waveforms. If you want to have a closer look at the inductance waveform, this is the orange line here. You will see the inductor current waveform like that.

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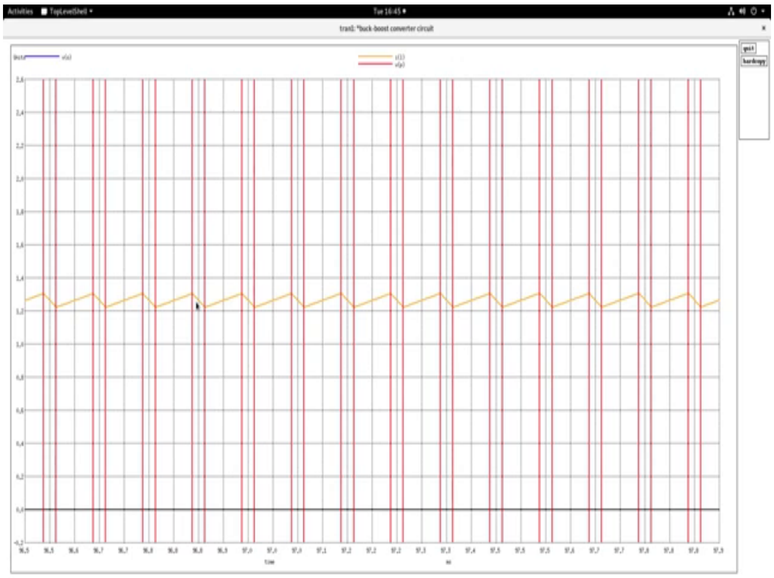

Slightly more amplified zone and then you see as expected, you will see the waveform of the inductor current in this fashion. So, again I will recommend that you try to understand as much as you can by changing the values and changing the frequency and probing at various points of the currents and voltages of the circuit.