Fundamentals of Power Electronics
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Lecture – 46
Volt-sec and Amp-sec balance

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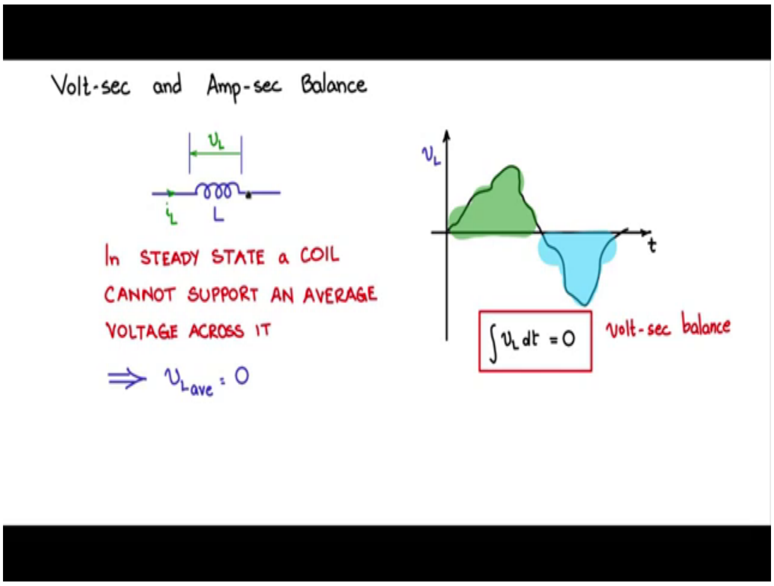

For simple switched mode power converter circuits like the Buck converter that we discussed it is easy to get the input output voltage relationship we saw that we had at the pole the pole voltage was chopped and taking the average of it, because it is going through an averaging network we got the relationship between V naught and Vi which was Vi into d the duty cycle.

But we would like to have a formal method of getting the input output voltage relationship or input output current relationship, because as circuits switched mode converter circuits become complex it may not be as simple and as evident as the case was for the simple buck converter. Therefore, we would like to use the method of Volt second balance or the Amp second balance the dual of this one. So, what is it?

So, if you take an inductor any inductor whichever circuit have an inductor L there is a voltage across the inductor we call that one as vL and there is a current through the inductor and called that as iL. In the steady state; in the steady state should be noted that the inductor cannot sustain or cannot support an average voltage. So, we can put that down like this cannot support an average voltage across the inductor.

So, it may be for any coil, so what it basically means that in the steady state the average voltage across the inductor is always 0. Of course, during dynamics there will be voltage fluctuations, but in the steady state you will see whatever be the voltages across that the average will be 0. So, let us take graph of across voltage across the inductor vL with respect to the time and let us say it is connected on network where there is an arbitrary voltage across the inductor could be any arbitrary voltage.

But one fundamental character of the coil of a coil or inductor, so in this waveform if you take the average of this waveform over a period it should be resulting in a 0 which means that 0 average, which means that the area under the top portion of the curve area under the bottom portion of the envelope they should match and then cancel each other and result in an average which is z which is 0.

If you take the area under the top portion it basically means that you are taking an integral of the Vi envelope to d t over the whole period and that should result in 0. Now this is very fundamental and it is called the Volt Second Balance equation. So, this volt second balance equation has to be satisfied for any coil any inductor in any circuit and under steady state it will always be 0.

Now, this is the guaranteed principle which is existing fundamental by nature and we will use that for developing or deriving the input output voltage relationship of any converter circuit.

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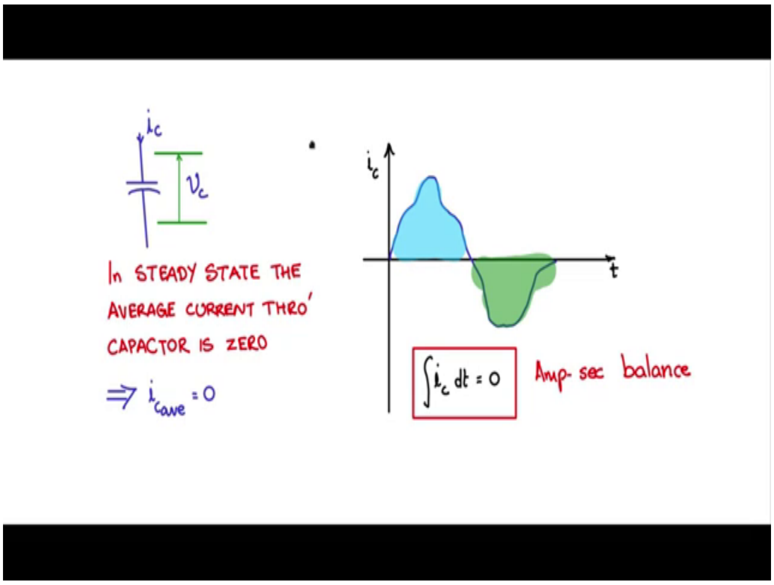

Exactly, the dual of the volt second balance across the inductor is the capacitors amp second balance condition. So, consider a capacitance and the capacitance has a voltage across it called v c and the current through the capacitance is called ic. In the case of the capacitance the steady in the steady state the current the average current through the capacitor has to be 0 always and that is fundamental and that is the relationship that we will be using.

So, which means i c average is equal to 0, if we now draw a graph of the ic current with respect to time and take an arbitrary current that is pushed into the capacitance, in order now to how charged build up this area the positive area under the i c envelope and the negative area of the i c envelope must match and cancel each other out and therefore, have average current equal to 0 in the steady state.

So, this boils down to integral of the current with respect to time and that should be equal to 0 in the steady state and that is called the amp second balance. So, the amp second balance condition is also a fundamental relationship and that is used for finding the input output current relationships of any given circuit or converter and the volt second balance relationship is used for finding the input output voltage relationship for the converter circuits. Now these 2 important fundamental relations we will use for finding the relationship between voltages and currents in various circuits.