DC Power Transmission Systems
Prof. Krishna S
Department of Electrical Engineering
Indian Institute of Technology, Madras

Lecture – 21
6 pulse LCC with inductance

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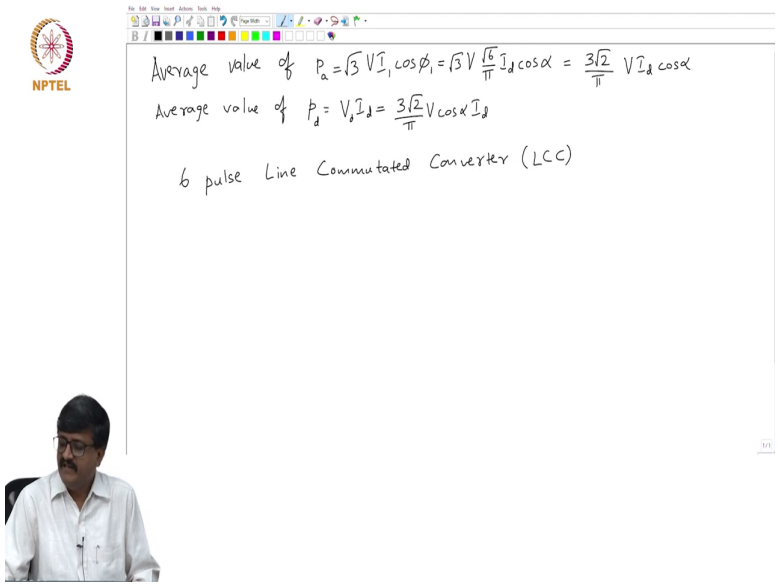

So, what we have considered till now is just the converter. So, the converter that we considered consists of actually 6 valves and of course, if you or try to name the converter in terms of the pulse number, I mean what is the pulse number? If you recall, we define a pulse number I mean.

Student: On their DC side.

Or a general mode

Student: Conceptual and

Yeah.

Student: DC

On the DC side ok. So, this I mean it one can also define pulse number as the number of pulses that you give to the thyristor valves in one cycle of the ac side waveform. Since there are 6 thyristor valves; if you take one cycle or 360 degrees the number of gate pulses given is.

Student: 5

6. So, it is a 6 pulse converter. So, I do not know whether you are familiar with the term line commutated converter. What is meant by line commutated converter?

Student: Which turns off (Refer Time: 01:09).

Yeah, you do not need a special circuit to turn off the thyristor. See please note we are not using any special circuit to turn off the thyristor. See thyristor is a semi controlled double device; that means, you can turn on by giving a control signal. The control signal is in the form of a gate current pulse.

Student: Yeah.

So, you can give a control signal to turn on, but there is no possibility of turning off by giving a control signal. So, it will turn off by itself based on the conditions of the power circuit when the current becomes 0; it turns off ok.

So, there is no turn off. So, there is no special provision for turning off. See if you want to forcibly turn off a thyristor valve, you should have some additional circuit as should be provision.

Now, in this case, there is no such provision. So, whatever happens for the thyristor valve is based on the power circuit. So, that is a line side; so, the that is why it is called the line commutated converter.

So, we say that the converter that we considered till now is a 6 pulse line commutated converter with AC side represented by just a voltage source ok. So, the that is a 6 pulse line commutated converter. So, many times this line commutated converter is abbreviated as LCC.

So, we have just analyzed line commutated converter which of course, a 6 pulse line commutated converter with a simplification of a the inductance on the AC side to be 0.

Now, that is just for the sake of simplification. In reality, there will be an inductance on the AC side because the AC side cannot be just represented by a voltage source; its voltage source is nothing, but the EMF induced transformer and a transformer invariably has a leakage inductance. So, some leakage inductance will be invariably there. So, AC side representation should be have inductance.

So, now, we will see how to analyze a slightly complicated circuit where in addition to voltage source on the AC side, there is an inductance in each phase.

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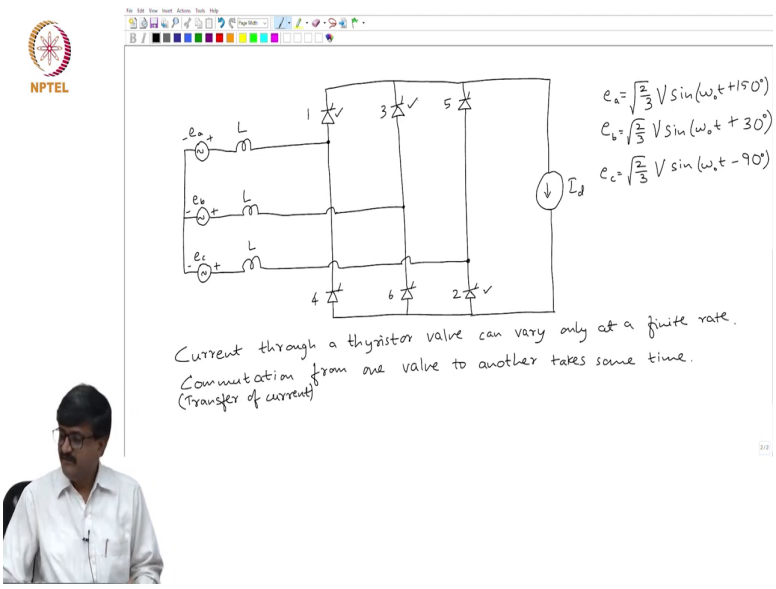

So, let us consider this circuit of course, I have a converter with three legs. The DC side is represented by a constant current source I d. On the ac side I have a three phase voltage source connected in y r star and in each phase on the AC side, there is an inductance the inductances in the three phases are identical. So, L be the inductance.

So, the voltage in phase a is e a in phase b, it is e b and in phase c it is e c. Of course, we will be using the same expressions for e a, e b, e c I mean the once which you have been using for the previous case root 2 by 3 V sin omega o t plus 150 degrees that is e a.

E b is root 2 by 3 V sin omega o t plus 30 degrees and e c is root 2 by 3 V sin omega o t minus 90 degrees. So, the thyristor valves are named as 1, 3, 5 for the upper commutation group and for the lower commutation group it is 4, 6, 2. So, the only difference is now there is

an L in the previous case L was 0. So, what is the change that one can expect due to the presence of the inductance on the AC side?

Student: Finite change in the current that we have to (Refer Time: 06:32).

Yeah, there was a discontinuity in the current see if you look at the current through the voltage source or current through the valve, there was a it can go from I d to 0, 0 to I d the valve current. But now a that sudden changes in the current through the source cannot happen. So, what does that mean? So, let us see.

Suppose, 1 is thyristor valve 1 is conducting; thyristor valve 2 is conducting ok. Now, if I turn on the next valve to be turn on is 3. So, if L is 0 whatever I d on the DC side that was flowing through 1 will instantaneously shift to 3. So, we say there is a transfer of current from valve 1 to valve 3 as soon as valve 3 stand on.

So, the this process of transfer of current is called commutation. I define this word commutation means the transfer of current from one valve to another in the same commutation group.

Now, can it happen if L is non zero? Say transfer of current from valve 1 to valve 3 actually means transfer of current from the inductance L in phase a to inductance L in phase b. So, suddenly the current through the inductance cannot go from I d to 0 in phase a and 0 to I d in phase b. So, it will take some non zero time for current to go from I d to 0 in phase a, 0 to I d in phase b.

Similarly, the same currents are flowing through the valves. So, the current through the valve cannot suddenly grow from go from I d to 0 or 0 to I d. So, what I mean to say is; so, let me just state that here current through a thyristor valve can vary only at a finite rate. So that means, if you take the rate of change of current with respect to time of course.

So, in the previous case it was infinite. So, there was a discontinuity in the current means it is a rate of change is infinite now; that is not possible with a non zero value of the inductance. So, this as good as saying a commutation from one valve to another; commutation from one valve to another. So, we already defined this word commutation; commutation means transfer of current transfer of current from one valve to another, takes some time.

So, just now I said suppose valve 1 and valve 2 are conducting; if valve 3 is stand on, current would not transfer to get transfer to valve 3 immediately. So, it takes some time; that means, there is a certain duration for which both valve 1 and valve 3 are conducting. Now, this is different from the previous case where at any time if you take any basic commutation group only one of the valves conduct at any instant.

Now, we have a situation where there are some instances at which two valves conducting ok. So, for a certain duration both 1 and 3 conductor of course, after some time 1 stops conducting. Again only 3 alone will be conducting from the basic commutation group consisting of 1, 3, 5 ok. So, what we do now is we try to define a duration for which both valves conduct.

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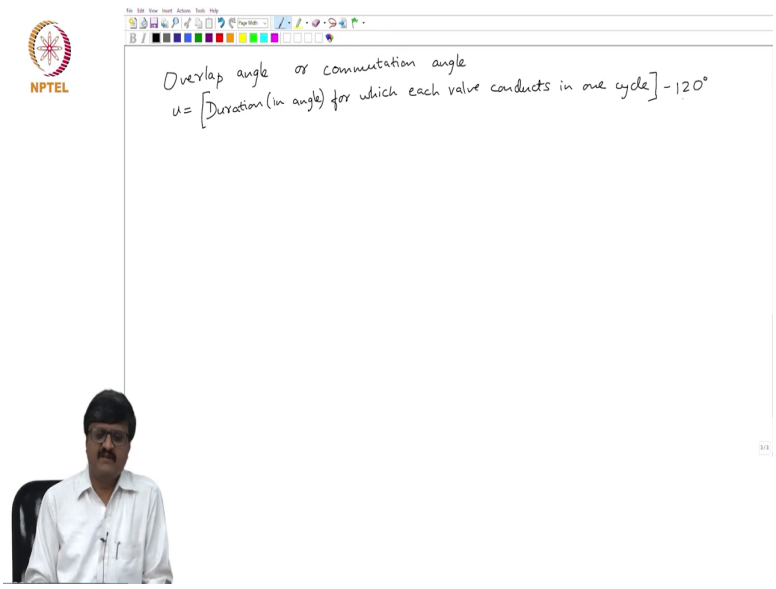

So, we will give a name for that that is known as overlap angle or commutation angle overlap angle or commutation angle. So, we use the letter u for this, the notation is u. So, let us see how to define this. So, the definition is simple.

I take the duration of course, I always measure the duration in terms of angle not in terms of time or independent variables angle; duration for which each valve conducts in one cycle. See our cycle is the cycle of the AC side minus what see I have to subtract something the this duration for which each valve conducts in one cycle that gives me the overlap angle.

Now what I mean is suppose L is 0, there is no overlap. See overlap means there is no duration for which two valves conduct ok. So, u or overlap angle or commutation angle is 0 if

L is 0. If L is non zero, there is a non zero u. So, what should I subtract from this duration to get u?

Student: Add time (Refer Time: 12:26).

Yeah what is that?

Student: (Refer Time: 12:28).

If L is 0, what is the duration for each valves conducts?

Student: 120 (Refer Time: 12:33).

Yes.

Student: 120 (Refer Time: 12:34).

120, it is 120. So, now, it is more than 120. So, do you remember this? We when there is no inductance on the ac side each valve conducts for just 120 degrees exactly in one cycle. So, there is a 120 degree duration.

Now, it is more than 120. So, the difference between duration and 120 is the overlap angle. So, that is the definition of u ok. So, u is the notation used for overlap angle or commutation angle.