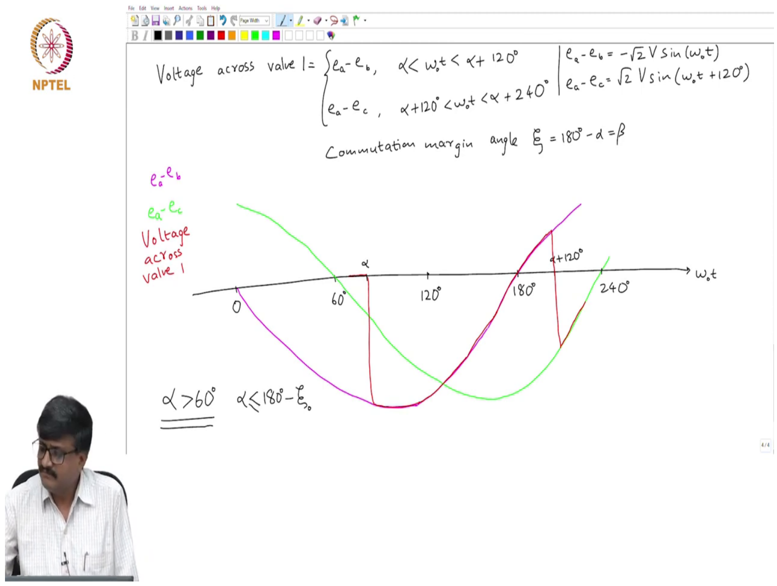
DC Power Transmission Systems
Prof. Krishna S
Department of Electrical Engineering
Indian Institute of Technology, Madras

Lecture - 17
Commutation margin angle in a 6 pulse LCC neglecting inductance: Part 1

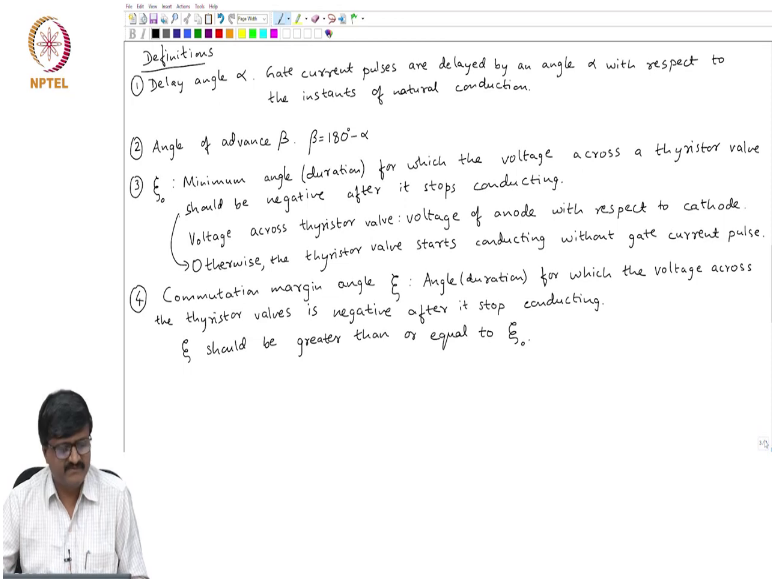
Now, let us just recall from the table that we have actually formed a few classes ago; we got the expression for voltage across the valve.

(Refer Slide Time: 00:28)



So, let us just see what is that the last column voltage across one of the valves; valve 1. Now, I said why we consider only one of the valves; the reason is all the valve voltages will be identical except for a phase shift.

(Refer Slide Time: 00:51)



So, even if you go back to the previous definition; see commutation margin angle, we say that the angle for which the voltage across the thyristor valves is negative; that means, for any thyristor valves it is negative ah for the same duration that is what I mean ok.

So, if you take the converter with six thyristor valves; for all the six thyristor valves, the angle for its the voltage is negative after it stops conducting the same ok. So, voltage across thyristor valve; so we will just consider we had six expressions corresponding to the six intervals, I will just consider the first two intervals.

The first two intervals are omega o t greater than alpha and less than alpha plus 60 degrees; alpha plus 60 degree less than omega o t, less than alpha plus 120 degrees. So, we got the expression. So, the first two rows I am taking. So, for alpha to alpha plus 60 voltage across valve 1, we got the expression as?

Student: e a minus e b.

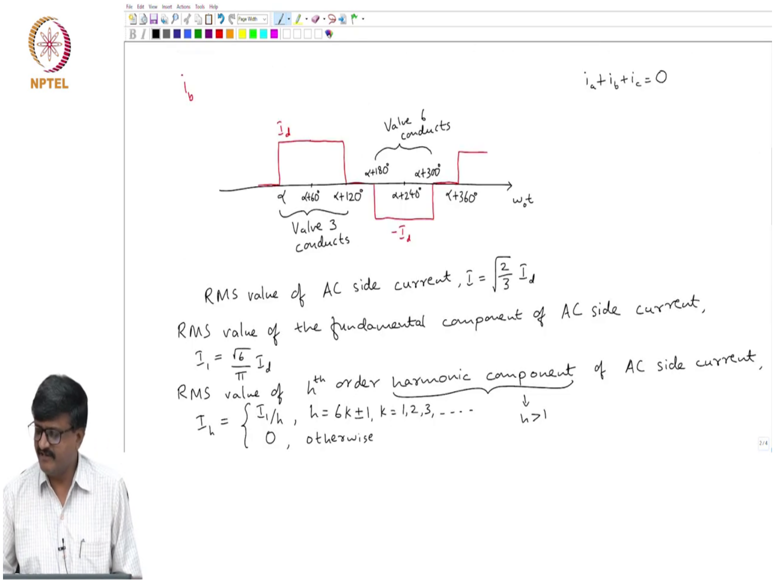
e a minus e b; and for alpha plus 60 degrees to alpha plus 120 degrees, it is? E a minus? We got the expression; e a minus?

Student: e a minus e b same (Refer Time: 02:08).

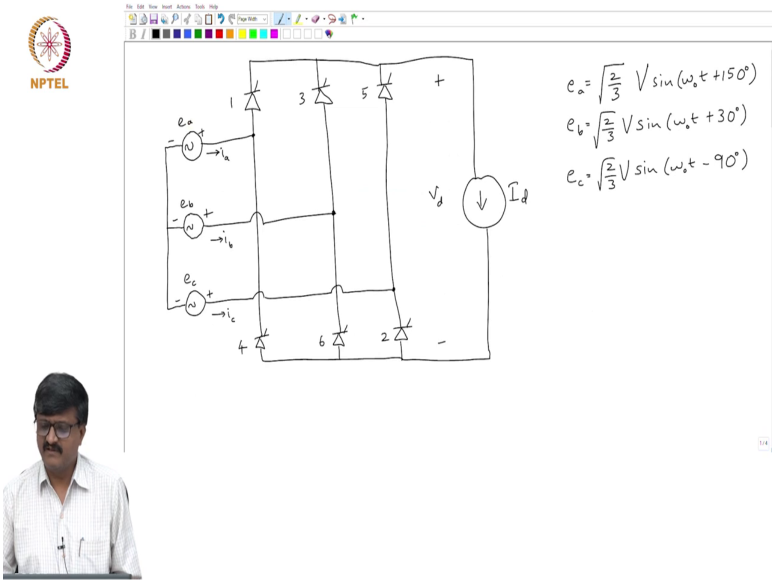
So, for the first two intervals; this is the, I mean we actually got the same expression. So, I could have written differently ok; what I can do is we can do this sorry; suppose I take the next two intervals alpha plus 240. So, from alpha plus 120 to alpha plus 240, it is e a minus e c. Yeah, I meant to just take these two expressions not two intervals, it is actually four intervals. Of course, there are two more intervals where it is negative sorry where it is 0; where it is 0 ok.

Now, let us try to plot this voltage ah; that means, the voltage across valve 1. See what is e a minus e b? Let us get the expression for e a minus e b; what is e a minus e b? We have the expression for e a and expression for e b.

(Refer Slide Time: 03:28)



(Refer Slide Time: 03:30)



e a minus e b; e a is having a phase angle of 150, e b is having a phase angle of 30. So, e a minus e b is a line voltage with RMS value V. So, it is root 2 V.

Student: Minus root V minus root V.

Yeah, minus root V sin omega ok. So, it is minus root 2 V; sin omega o t; then there is another expression for voltage across valve 1 e a minus e c. So, if you look at the expression for e c, the phase angle is minus 90; so e a minus e c is root to V sin omega o t; e a is having phase angle of 150, e c is having a phase angle of minus 90. So, minus e c will have a phase angle of plus 90. So, one is 150, another is 90; so the resultant is e a minus e c 120. So, it is root 2 V sin omega o t plus 120 degrees.

Now, let me try to plot voltage across valve 1. So, what I am trying to do here is plotting voltage across valve 1. So, before that; I will just try to plot e a minus e b and e a minus e c also so that over that I can plot voltage across valve. Suppose, this is 0; this is say 60 degrees, 120, 180 degrees, 240 degrees.

So, if I plot e a minus e b; e a minus e b is minus root 2 V sin omega o t. So, there is a negative peak at 90 degrees; what I am plotting is e a minus e b first, minus root 2 is sin omega o t; is that ok? See the peak value is at ok; not be a very neat sketch. Then suppose I plot e a minus e c; e a minus e c is root 2 V sin omega o t plus 120; so where will the 0 crossing of this be? So, there will be a 0 crossing from positive to negative what e a minus e c, e a minus e c will have a 0 crossing from positive to negative; what?

Student: 300.

Sorry.

Student: 300.

300; anyhow 300 I have not shown here, what I was shown is 0, 60, 120, 180, 240; 60, 60. Yeah is a just a rough sketch ok. Now, suppose I have alpha say greater than 60 degrees; suppose alpha is greater than 60, let us make this assumption; we will consider what happens if alpha is less than 60 later.

Suppose alpha is greater than 60 degrees then from alpha to alpha plus 120; it is the voltage across valve 1 is e a minus e b. So, suppose I will plot e a minus e b; sorry, I made a mistake. Suppose, I plot voltage across valve 1 using this red line voltage across valve 1; so from alpha to alpha plus 120 it is e a minus e b; so I will show somewhere alpha, alpha is somewhere here this is alpha. So, up to alpha; that means, just before alpha; what is the value of voltage across valve 1?

Student: 0.

Why?

Student: Because (Refer Time: 09:57) Eigen.

See.

Student: This is a.

Alpha is the instant at which; which valve turned on, which valve is turned on at alpha?

Student: 3 is turned on.

3 is turned on; see alpha is the instant at which 3 is turned on. So, before 3 being turned on which valve is conducting?

Student: 1.

1 is conducting. So the; I mean we are trying to plot voltage across valve 1, when valve is conducting voltage across the valve is 0. So, voltage across valve 1 before alpha is 0 is 0. So, I will just show for a small duration for which it is 0 ok; I am not trying to show it from 0 to alpha, I am just showing for a small duration before alpha. So, at alpha it jumps to?

Student: e a minus e b.

Voltage across valve 1, jumps to e a minus e b. So, e a minus e b is this valve. So, it remains at e a minus e b up to? Up to what?

Student: (Refer Time: 10:52).

Up to?

Student: Alpha plus 120.

Alpha plus 120, so alpha plus 120 comes after?

Student: After 180 degrees.

After 180 degrees because I assumed alpha greater than 60; so alpha plus 120 is after 180 degrees, so up to alpha plus 120 the voltage across valve 1 is e a minus e b. So, this red line coincides with this curve e a minus e b; then what happens at alpha plus 120?

Student: (Refer Time: 11:34).

It becomes e a minus e c. So, it jumps to e a minus e c ok. So, this red line is the voltage across valve 1; now just go back to the definition of the commutation margin angle psi. What is the commutation margin angle; that by definition it is the angle for which the voltage across the thyristor valves is negative after it stops conducting. So, if I take voltage across valve 1; it valve 1 stops conducting at?

Student: Alpha.

Alpha; so what is the duration for which the voltage across valve 1 is negative? So; that means, what is the commutation margin angle?

Student: 180 angle; 180 minus.

180 minus alpha

Student: Beta.

So, commutation margin angle psi is 180 degree for this case minus alpha which is nothing, but beta by definition beta is 180 minus alpha. Now, this is as far as the range of alpha from 60 to some value which we have to determine.

Now, this diagram actually; this waveform actually tells us what is the upper limit on alpha. So, looking at the previous definitions, can we say if alpha is greater than 60? Can it go up to any value or is there a limit?

Student: There is a limit.

What is the limit?

Student: Such that 180 minus alpha is always greater than or equal to epsilon.

Yeah. So, there is a quantity called psi naught; there is a minimum duration for which the voltage should be?

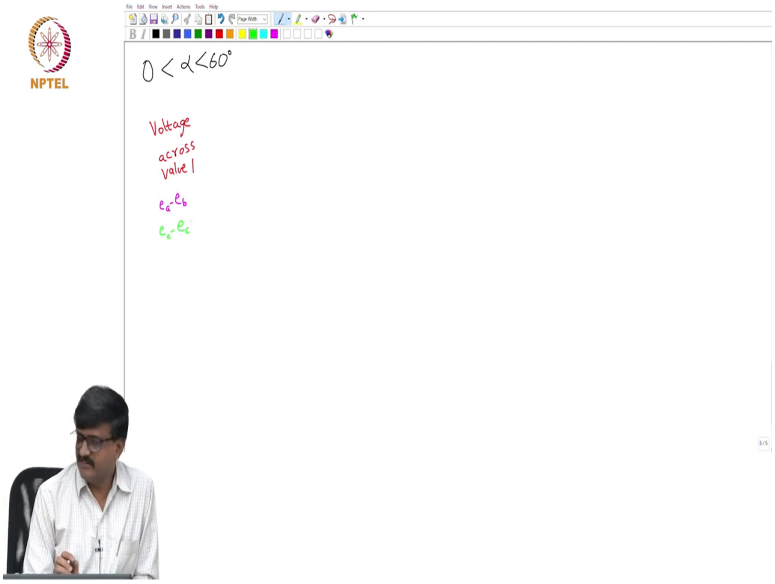
Student: Negative.

Negative. So, alpha cannot go up to 180; it can go only up to?

Student: 180 minus psi naught.

180 minus psi naught. So, alpha is greater than 60 and alpha is actually less than 180 minus psi naught ok. If can of course, take the value of 180 minus psi naught of less than or equal to 180 minus psi naught.

(Refer Slide Time: 14:32)



Now, let us consider the other possible range of alpha. So, that was for alpha from 60 to 180 minus psi naught. So, what happens to alpha less than 60? Yeah, please note psi naught is a small value; it is of the order of 10 to 15 degrees ok; it is, I mean it is a small angle compared to 60 degree; it is a small angle.

Now, let us see what happens if alpha is less than 60 degrees and of course, greater than; greater than? What is the minimum possible value of alpha?

Student: 0.

0. So, between 0 and 60; what will be the waveform? So, what I want is the voltage across valve 1; voltage across valve 1. Of course, I can also plot to this e a minus e b and e a minus e

c and from that I can plot voltage across valve 1 ok. And once I plot these waveforms, I can get the expression for the commutation margin angle. So, can you just attempt this?