DC Power Transmission Systems
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Lecture – 65
Double tuned and damped filters

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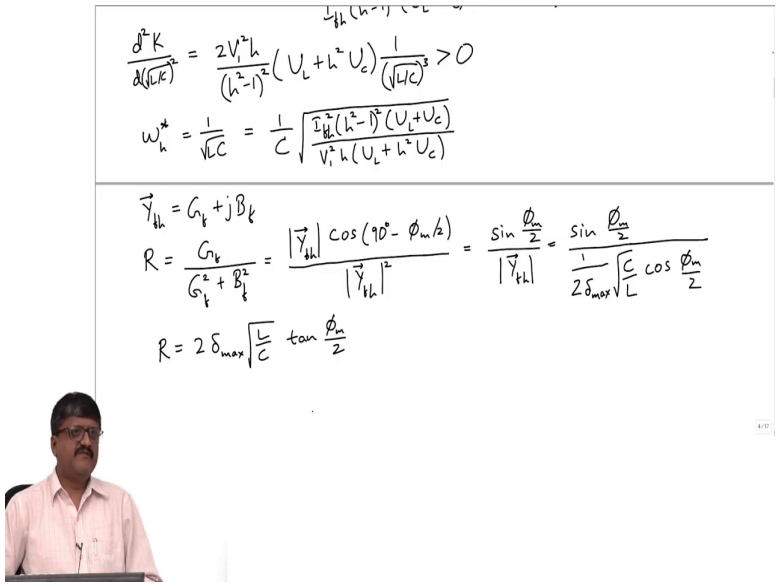

Now, what one can do is, if I want to eliminate the harmonics, see all these filters are the ac side filters to eliminate the harmonics or minimize the harmonic components in the current. So, the dominant harmonic is the most dominant harmonic.

Student: (Refer Time: 00:33).

What is the most dominant?

Student: 11th.

11th. Please note we are using a 12-pulse converter in practice. So, the 11th harmonic is the dominant harmonic. So, I can use single tune filters for some dominant harmonics, say 11th, I can use one for 11th, one for 30. See it will work for only one frequency that is why it is called single tuned. So, I can use it for one dominant frequency. If I want for another dominant frequency, the next one is 13th, I should use one more single tune filter. Then the next one is 23rd, one more 25th one more, but there are infinite number harmonics.

So, we will not be using infinite number of filters, we will use a few single tune filters for a few dominant harmonics. And for the rest, we will use one single filter which is a damped filter, which will try to; in fact, filter out all the remaining harmonics, ok. Now, instead of that what one can do is instead of a single tune filter, we can also have what is known as a double tuned filter which will act to minimize two frequencies. So, it will do the job of two single tuned filters.

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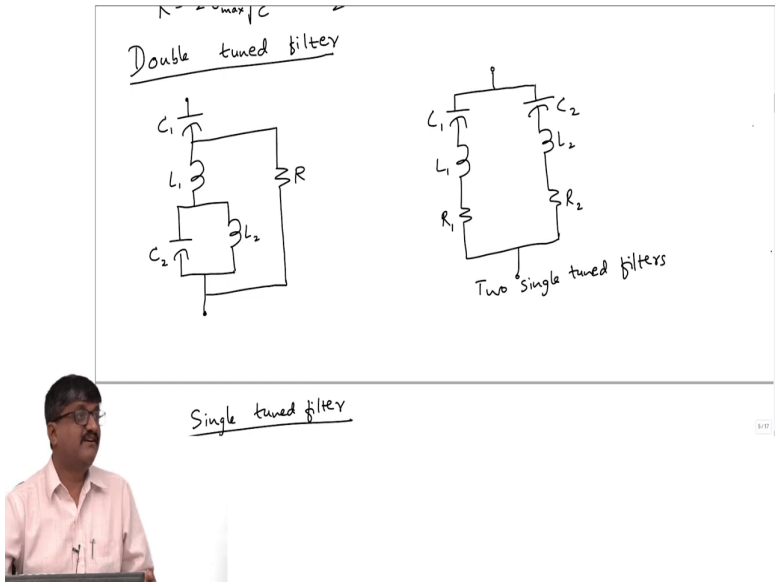

So, I can have instead of two single tuned filters, one double tuned filter.

Now, I will just give the circuit diagram. We will then see how it works. See double tuned filter is having a circular like this. So; obviously, there should be two inductors and two capacitors. But, how the two inductors and capacitors are arranged is like this. So, there is also a resistance. So, it is a two terminal device where I have two capacitances C 1 and C 2 and two inductances L 1 and L 2 and suppose this resistance is R.

So, I can as well have this arrangement. This is what we have already studied single tuned filter. Suppose, I have R 1, L1, C 1; R2, L 2, C 2; this is two single tuned filters. Now, instead of this arrangement, we can have what is known as a double tuned filter..

Now, I mean there may be some reason; there should be some reason for using a double filter instead of two single tuned filters. Single tuned filters are obvious, I mean why one should use a double tuned filter ok? Do you see any advantage? Now, when a filter suppose I take a single tuned filter, it is subjected to impulse. So, which element is subjected to impulse? See I have an inductor and a capacitor in series; forget for a time being resistance. So, which among the two is subjected to impulse?

Student: Inductor.

Inductor; but, it is a inductor which is subjected to the impulse. Now, both inductors are subjected to the impulse, if I use two single tuned filters. Now, look at this circuit of double tuned filter. If there is an impulse, then there is only one inductance which subjected to impulse. Which one?

Student: (Refer Time: 04:32).

Which one?

Student: (Refer Time: 04:36).

No. The answer you gave for a single tuned should be can be used to give the answer for this.

Student: L 1 (Refer Time: 04:47).

Student: L 1.

L 1, it is L 1, because L 2 is across the capacitor. So, L 2 is across the capacitor. So, if there is an impulse, only L 1 needs to be designed for the impulse. So, that advantage is there. Of course, there are a few other advantages, one can I mean get into the details and try to show that the power loss at fundamental frequency is considerably reduced in the double tuned

filter. So, we will not get into all those details, but there are some advantages. So, these are double tuned filter ok.

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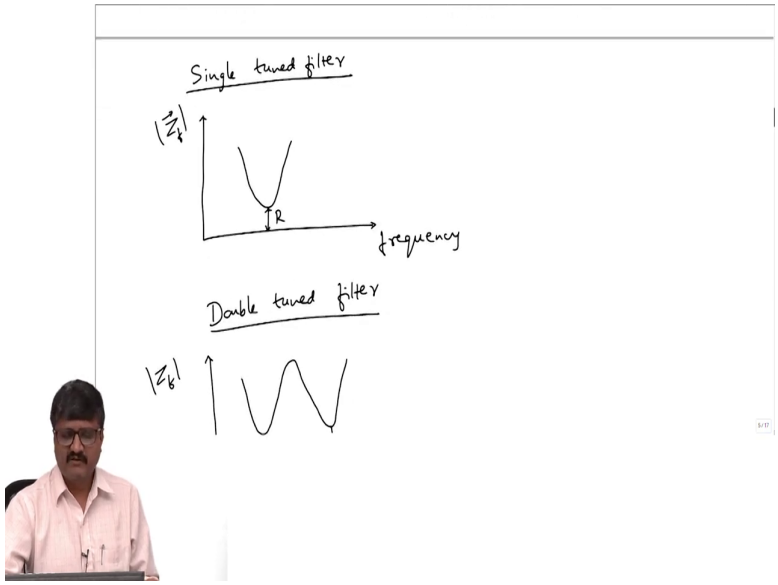

Now, the question is, how is this double tuned filter supposed to behave ? See in the case of single tuned filter; see if I take a single tuned filter, suppose I plot the magnitude of the impedance of the filter as a function of frequency ok. So, it is somewhat like this there is at one value, I get a minimum value of impedance. What is that minimum value for single tuned filter?

Student: (Refer Time: 06:00).

What is this value?

Student: (Refer Time: 06:03).

The minimum value of the filter impedance for a single tuned filter, at some frequency it is minimum.

Student: (Refer Time: 06:14) Resonant frequency.

Student: Resonant frequency.

Resonant frequency, what is the value of the impedance?

Student: (Refer Time: 06:20) R.

Is equal to.

Student: R.

R, it is R that is all, it is just R ok. The effect of inductance and I mean the reactance of the inductor and capacitor will be same at the resonant frequency. Now, for the double tuned filter, the graph is like this. If I plot as a function of frequency, the magnitude of the filter impedance, then I get two minima, instead of one minima, I get two minima. So, it is somewhat like this ok.

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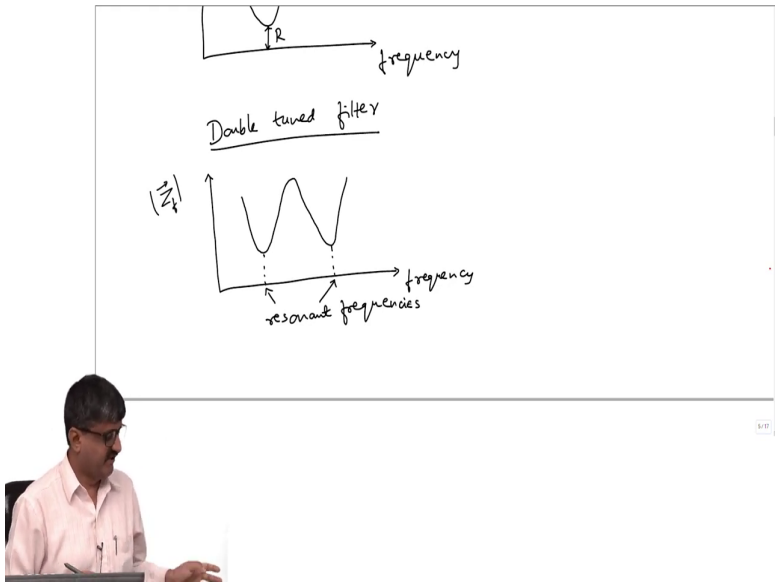

So, again these two values of frequency at which I have minima or known as the resonant frequencies. So, these two are called resonate frequencies. So, what I would ask you to do is, try to get an expression for the resonant frequencies. Of course, one can make an a simplification neglect R; see neglecting R means, what do you meant by neglecting R? R is.

Student: (Refer Time: 07:45).

Student: (Refer Time: 07:48).

No, from the context you should try to make out, what is meant by neglecting R?

Student: Open circuit.

Open circuit, infinite impedance. Neglecting R means, R has infinite value. So, if I neglect R, then it becomes very simple. Then at the resonant frequency what will be the impedance, if I neglect R?

Student: (Refer Time: 08:10).

It will be.

Student: 0.

0. It will be 0. So, try to find the expression for the resonant frequencies by neglecting R. But when I have more than one frequency is to be damped, I cannot be using only tuned filters. So, what I will do is, instead of using many tuned filters, we will restrict our number of tuned filters and use one another filter called damped filter.

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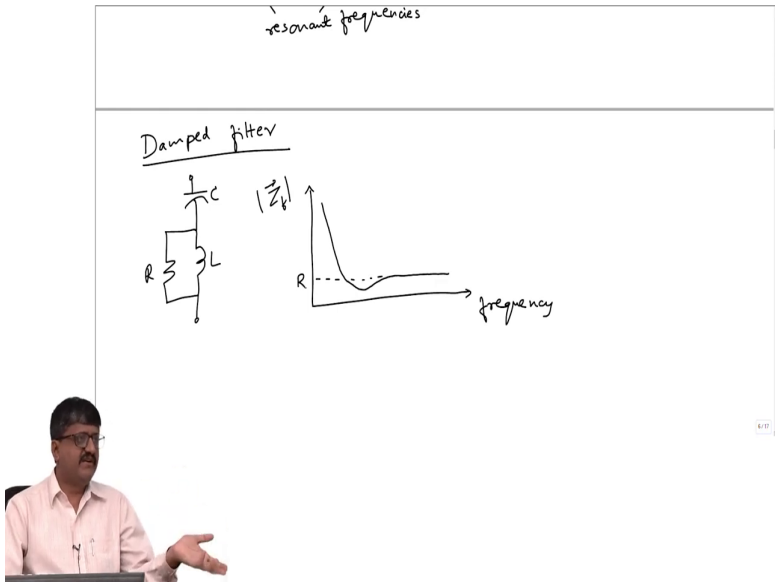

So, it is a high pass filter; that means, all the high frequencies will pass through that. A Damped filter is it like this, it has a capacitance, inductance and a resistance connected across; the inductor, resistance is connected across the inductor. So, if you look at this plot of magnitude of impedance as a function of frequency so, here suppose let me call this capacitance L inductance , capacitance C inductance L resistance R.

So, here as the frequency increases, the impedance decreases reaches a minimum and slightly increases and approaches a value ok. So, it is essentially having a very low impedance for all frequencies beyond a certain value. So, beyond a certain value of frequency, it will have very low impedance. Now, this is in contrast with the tuned filters where the impedance is low at only a small a range of frequency around the resonant frequency. So, it will approach some value. What is the value? So, the magnitude of the impedance approaches some value, what is

that? It will approach some value, what is that? As frequency tends to infinity, what is the limit of magnitude of Z f? Look at the circuit.

Student: R.

R. It is R ok. L becomes an open circuit; C becomes a short circuit. So, it is R ok. So It is a essentially having a constant impedance for all frequencies beyond a certain value. So, we can use a few single tuned filters and damped filter or double tuned filters and damped filter any combinations.