Electrical Measurement and Electronic Instruments
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Lecture – 33
AC Potentiometer

Welcome back. So, in our last class, we have talked about DC potentiometer and we have measured unknown DC voltage. In this class, we will talk about AC Potentiometer. And I hope the calibration and measurement phase was clear to you; otherwise it will be difficult to understand this class ok.

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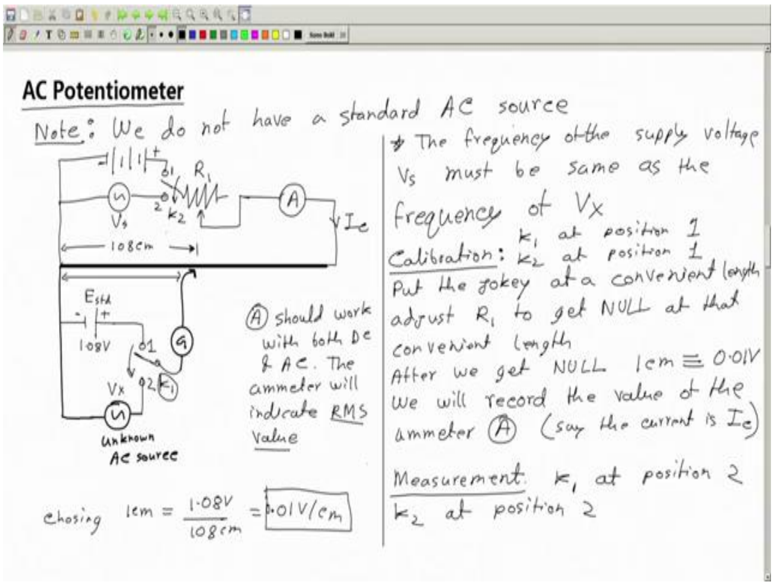

Now, the first difficulty that we have when measuring AC voltage with potentiometer is that there is no standard AC cell ok. So, we do not have a standard AC source, which we can rely on. I mean whose value does not change with any factor in I mean, so there is not as there is no such reliable AC source ok, which we can call as standard. This is the difficulty.

And in this talk in this class, we will see how to use DCs standard cell; DC standard cell to measure unknown AC source using potentiometer. So, what we will do? Ok so, let us first draw the; so, this is the long wire of the potentiometer with uniform cross section. Now, we want to measure a unknown source which is AC.

So, let us draw the unknown source; so, this is a unknown AC source ok. So, the way to connect it is of course, like this. Connect one side to one terminal of this potentiometer, where another side to a galvanometer and we will use a Jokey which can move along this wire. So, that we will find the null and by noting the length from one side to the jokey, we will find the value of the EMF that is the way we do it right.

But now, we need a supply; I mean a voltage supply here without which it will not work so, that is the main thing. So, let us put a voltage supply. So, this is connected across the two ends of the potentiometer. Now, this source must be AC right. This must be also AC because if this is not AC, then the potential drop here will also not be AC and then, we cannot get a balance. If this is DC, a DC cannot balance AC ok. A DC voltage can never be equal to a AC voltage.

And also another important thing, we need is that the frequency of this AC source must be same as the frequency of the unknown source ok. So, important point; the frequency of the supply voltage by supply I mean this call this V_S; frequency of the supply voltage V_S must be same as the frequency of this unknown voltage call it V_X; must be same as the frequency of ok, else we will never get a balance.

Now, you also have seen that in case of DC, we actually use another standard voltage source and then, we first do this standardization by connecting this galvanometer initially to this ok. So, we may have a switch. So, in the standardization phase, if you recall what we did in case of DC, we first connected to the standard cell and then, we set this to a desired length; a convenient length and then, we adjust the current through the wire. So, for that we need a rheostat ok.

So, you can also draw a rheostat maybe like this, if you like R1. So, calibration step is; calibration so, it means put the jokey at a convenient length ok; do not move the jokey and do not move it anymore. Instead adjust R 1; adjust rheostat R 1 to get null at that convenient length, that is what is calibration.

But as I already have said the problem is we do not have a standard AC source. If we had a standard AC source, we would have done this in a same way like we did for the DC ok. But we do not have a standard AC source. So, what we do is this. We instead connect a DC source; standard DC source E std and we connect the jokey here. So, put it at say K1 ok, switch call this switch as K1.

And this is position 1, this is position 2. So, I can write K1; switch K1 is at position 1 during the calibration and then, we will; again we will put the jokey at a convenient length. So, whatever length we choose ok; so, for example, if this is 1.08 Volt. So, we may choose say this length; this convenient length to be say 108 centimeter ok for example, we can choose this as 108 centimeter.

So, which will imply that one centimeter is 0.1 Volt ok. So, choosing 1 centimeter is equal to 1.08 Volt by 108 centimeter which is 1 by 100 so, 0.01 Volt per centimeter. So, this is the choice. We have made for calibration for example, you can do it. But now there is a problem, the problem is this is now DC this is AC, we can never get a balance. So, we can never get a balance therefore, we also need a DC source here, but we need a AC source for measuring this unknown. So, therefore, we will have two sources ok. So, we will have another DC source and say we can connect this there is a key say which can connect between this call this K as K2 position 1 and position 2 ok.

So, during calibration therefore, we must have; so, we should have K1 at position 1 here. So, the galvanometer is connected to standard cell and K2 at also position 1. Now, the supply is also connected to this battery DC ok. So, this is at position 1, this is also set position 1. Now, you choose a convenient length which we have chosen like this. So, we put this at 108 centimeter for example, this is an example only ok. And we adjust R 1 until we get the null and once we get the null, after we get null, then 1 centimeter will be equivalent to 0.01 Volt; 1 centimeter will be equivalent to 0.01 Volt, this is calibration step.

Now, we will go to the measurement step, but before we can go there, we need another important thing. We need an ammeter A and this ammeter should work both with this DC and AC. So, this can be like an electrodynamic meter ok, so, this ammeter let us we write here ammeter A should work with both DC and AC.

So, like electrodynamic meter. So, this will indicate; So, the ammeter will indicate the RMS value ok. So, the ammeter will indicate the RMS value, not the average value. Because this is the AC meter which works both with AC and DC ok. So, this is important. So, we will do one more thing in the calibration phase which is we will record or note the value of the ammeter A; call this value is say the current is I c ok, say this current is I c; current during calibration.

Now, in the measurement phase, what we will do? Of course, we have to go to the unknown source. So, switch K to K1 so, this switch K1 will be K1, we have to move it to position 2 and this switch now this is AC so, here we also need an AC. So, this also will be moved to position 2. So, K2 at position 2 so, this is the in the measurement phase.

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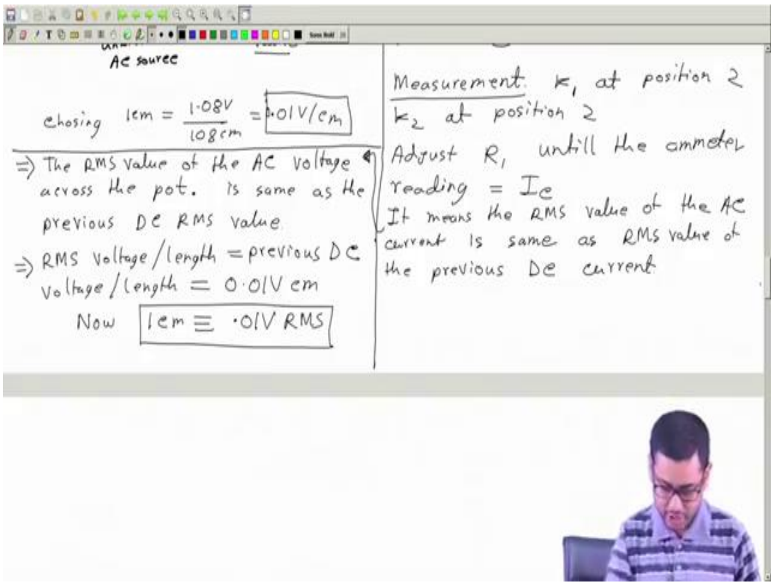

Now, what we will do, we will adjust reuse that R 1 until the ammeter reading is same as I c. What is I c? It is the RMS current which was flowing through this wire during the calibration. Now in the measurement phase when we have changed everything the source is changed here; here also the source is changed. Now we will adjust this rheostat once again so that we get the same value of current I c.

Now, if we have the same value of current I c ok, but previous I c was DC. Now this I c is AC ok. So, by when I say that same current I c is flowing, it means the RMS value of the current is same ok. Actually one current is DC; another current is AC. But their RMS value is same. So, it means the RMS value of the AC current which is flowing now is same as RMS value of the previous DC current.

If so ok, if that is the case, so let me write here now ok. So, this ensures that so, if same RMS current is flowing, then the RMS value of the voltage across this wire is same, all though previously it was DC, now it is AC, but their RMS value is same. So that means, the RMS value of the voltage AC voltage across the potentiometer pot in short is same as the previous RMS value; previous DC RMS value right.

Now, for DC RMS is same as the average or the DC value itself. So, therefore, we can say that the RMS value of this voltage here to here is same as the DC voltage which was here previously or we can also say the RMS value per unit length of this wire is same as the DC value which was there previously per unit length of the wire right. So, RMS voltage per unit length will be same as the previous DC voltage per unit length which is same as this 0.01 Volt per centimeter by choice. This is what we have chosen ok.

So, now, we can say therefore, in this wire each centimeter represents 0.01 Volt RMS. So, now, we have 1 centimeter is equivalent to 0.01 Volt RMS right ok. So, if so now, we can adjust. So, now, this key is that it is connected to this unknown source so, now we can adjust the position of this jokey to find the null with this unknown source and that will give us the value of the unknown source.

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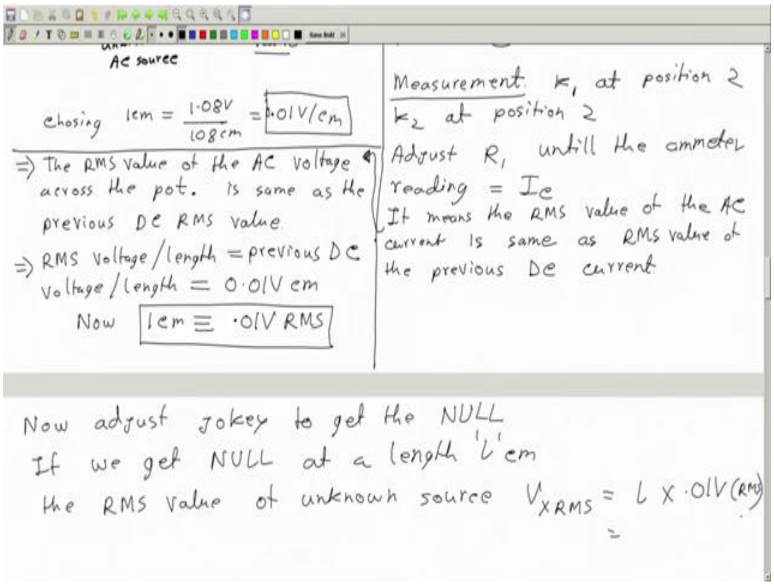

So, now in the measurement phase adjust jokey to get the null. If we get the null at a length L from the left side then, RMS value of the unknown source which is V X RMS will be same as this length L multiplied by if this is L centimeter multiplied by 0.01 Volt RMS.

So, this will be 1 0; I mean whatever this is so, this way we can measure it. So, this is the trick. So, the problem was there is no standard AC cell, no standard AC source. So, by intelligently using this DC cell to calibrate this wire, we actually have; I mean we actually have made these potentiometer useful for AC as well ok. So, this is the trick for using AC sources.

Now, I will conclude this video, this class with a question. The question to you is that we have said that these supply voltage and this unknown voltage must have same frequency; otherwise we will not get balance or null at all. But is that enough, what if this supply voltage and this source; so, the supply voltage and this unknown source has different phase angle.

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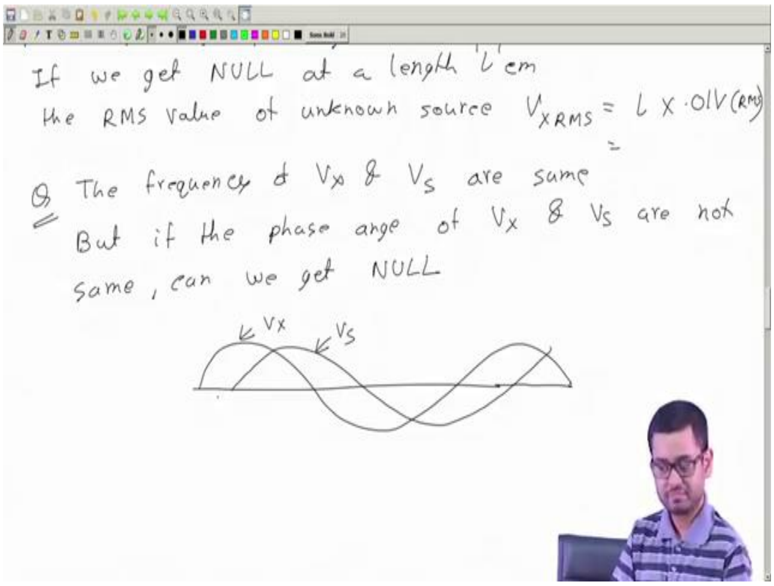

So, the question is the frequency of V X and V S are same. But if the phase angle of V X and V S are not same; can we get null at all? So, if V X is like this and if say V S is like this; same frequency, but they have a time delay between them, time difference between them. So, they do not reach they are peak and 0 simultaneously. So, can we ever get a NULL? I think no; so, think of this and we will in our next class start our talk with this question.

Thank you.