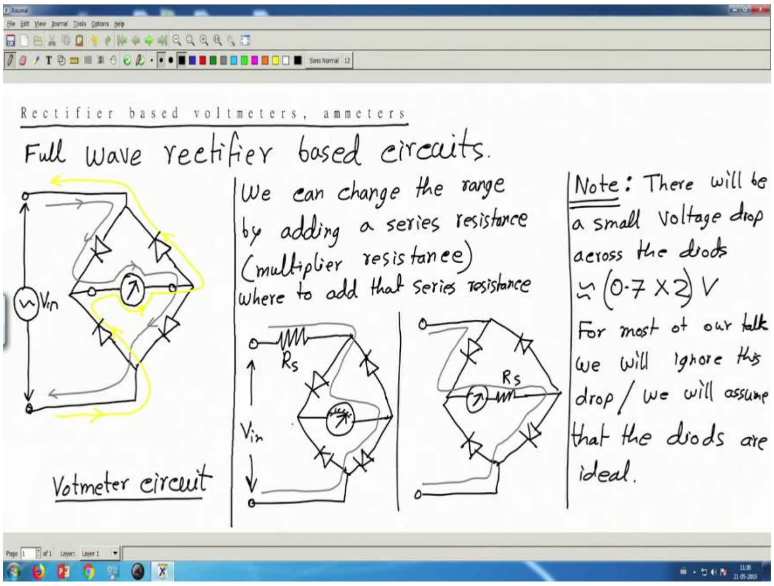
**Electrical Measurement And Electronic Instruments**
**Prof. Avishek Chatterjee**
**Department of Electrical Engineering**
**Indian Institute of Technology, Kharagpur**

**Lecture - 19**
**Rectifier based Voltmetesr and Ammeter – II**

Welcome back. We were discussing about Rectifier based Voltmeters and Ammeters. And just to motivate this talk once again. So, we said that PMMC meters on one hand it is quite sensitive compared to say electro dynamic medias particularly for low values of currents, but the problem is PMMC meter cannot measure AC; because for AC the average torque will be 0 and the pointer will not move.

So, to get the benefit of high sensitivity using PMMC meter, we can actually combine PMMC meters with rectifier circuits diodes and therefore, we can simultaneously get an instrument which can measure with high sensitivity or higher sensitivity and it can also measure AC voltages or currents ok. So, in our last video we have talked about half wave rectifier base circuits and that was actually very simple. So, today we will talk about full wave rectifier based circuits ok.

(Refer Slide Time: 01:49)




So, full wave rectifier based circuits ok. So, let us recall what a full wave rectifier is. So, it is made up of four diodes in the form of a bridge so; that means, it has four arms and it has four diodes in the four branches and we can connect say the input between two opposite corners say this is the input and the output of this rectifier will be between the other two corners of this square or rhombus whatever you call and we would not say if a AC voltage is given between these two points say here. So, call it V in ok.

So, we are making a voltmeter circuit and this is the input in for i n input and what we will like to have is that for say positive cycle if current flows like this ok. So, here from left to right then in the negative cycle, we would like the current to flow say like this ok. So, in both the cycles we would like the current to flow here in the output which I have not drawn it from left to right only ok.

So, this is the desired direction of the rectifier ok. So, do not memorize any circuit that is my suggestions circuits are very logical things, you think what you want to do and you can always get that done. So, this is what I want ok. So, I could have drawn the circuit directly, but I am trying to motivate how to find or how to make this circuit on your own if you ever forget how it looks like. So, this is what we want ok.

So, now, so, here let me put a diode. So, I want the current to flow in this direction. So, I will put the diode like this, similarly here I would like to put a diode. So, let me put diodes along the direction of arrows ok. So, I just have followed the direction where in which direction I want the current to flow and I have put these diodes accordingly. Now where is the meter or where I mean what is there in the output? So, the output of this rectifier will be connected to a DC meter a PM MC meter maybe. So, let us do that. So, let us draw a PM MC meter ok. So, I think now I can erase this arrows.

So, let me draw a PM MC meter like this and like its connected like this ok. So, current always flows from left to right in this through this meter no matter whether its the positive cycle or negative cycle. So, this is the circuit ok. So, now, if I apply a voltage V in here which is us which is sinusoidal, here through the meter current will be always in one direction the current will be unidirectional. So, therefore, the pointer can move to one side. Now so, this is the circuit for full wave rectifier based voltmeter ok.

Now in volt meters. So, this is the input voltage where we will connect the unknown source. So, if I have a unknown source which I want to measure. So, I will I can connect it here. So, this is the source of the EMF or the voltage ok. Now the recall that when we were talking about. So, we can change the range by adding series resistance or which we call the multiplier resistance. Now the question is where should I add the add that series resistance in this circuit? So, we have now the question is where to add that series resistance? We have many choices two choices at least.

So, we can add it here ok. So, this is the series resistance or multiplier resistance R s ok. So, this is actually in series with the voltmeter circuit. So, this is input voltage. So, you can add it like this, you can also if you want you can also add it here no problem. So, everything is quite logical you need not memorize any circuit. So, you can add it just beside the meter ok; because in either case this resistance is in series with this meter, if you consider the path of the current.

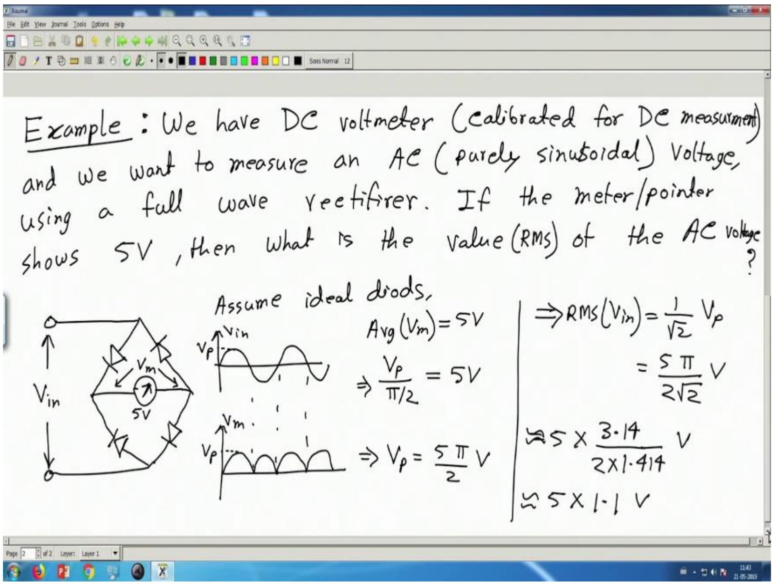
So, the current flows like this. So, you see that the meter and this resistance is in series and here also if you think like this, the meter and these resistance they are in series ok. So, how can you add it in either way; now a small note that there will be a small voltage drop across the diodes ok.

So, which is in this case its like approximately 0.7 volt, which is the cutoff voltage for a silicon based diode multiplied by 2 volt ok. So, because there are two diodes in series with the meter in any circuit even in the positive and even in the negative half of the cycle. So, here these two diodes are in series with the meter and in the other half of the cycle this two diodes are in series with the meter. So, this voltage drop occurs and for better accuracy, we should consider this drop while calibrating or marking the scale of this meter ok.

So, we should consider that there is a drop. So, basically the voltage that appears say across this meter and the series resistance is V in minus this 0.7 into 2 that is 1.4 volt. So, we should know that there is a 1.4 volt of 4 volt drop, which we should consider for weighted calculations, but for most of our talk we will ignore this at least initially we will ignore this ok.

If time permits later on we will see how to incorporate this drop as well in our calculation. So, for most of our talk for most of our talk, we will ignore this drop or that means, we will assume that the diodes are ideal ok. So, no voltage drop occurs across the diode when the current is flowing in the forward direction. So, this is full wave rectifier based circuit.

(Refer Slide Time: 13:57)




Now, let us take a small example. Suppose I have we have a PM MC meter or say let me call it a DC voltmeter so, calibrated that. So, this means this is calibrated for a DC voltage measurement calibrated or a marked for DC measurement we have a DC voltmeter and we want to measure a sake an AC voltage AC purely sinusoidal of course. So, this is the assumption we are making always.

So, we want to measure an AC voltmeter AC voltage using a full wave rectifier. Now if the meter or the pointer shows 5 volt, then what is the value of the AC voltage unknown AC voltage? Now, when we say the value of an AC voltage if we say not if you do not mention anything else it by default means the RMS value ok; in case of AC by default we always mean RMS value. So, the question is what is the RMS value of the unknown AC voltage if the meter is showing 5 volt this is a DC meter? So, once again my circuit is like this and I am not using any multiplier resistance as since it is not mentioned ok.

So, this is the circuit, now this is a DC voltmeter and it is showing 5 volt. So, the pointer is indicating 5 volt, now the question is what is the value of RMS value of this voltage V in? Now so, we will ignore the diode drops. So, assume ideal diode therefore, we know that the voltage across this meter the average voltage across this meter is 5 volt because DC meters like PM MC meter always indicates the average value ok. So, the and the waveform across the meter. So, if I call this voltage across the meter as V m, so, which is between these two points ok. So, we can draw the waveform if V in is like this, then V m will be like this ok.

So, this is V m and we know the average value of this V m is 5 volt. So, average of V m is equal to 5 volt. So, this is shown by the meter ok. Now let us call this height as V p peak. So, this will also be same as V peak if this has a height or an amplitude of V p, the V m will also have same amplitude V p because we are assuming the diodes to be ideal no voltage drop occurs across this diode. So, the average, so, the peak voltage across the meter will be same as the peak of the input ok.

Avg (Vm) = 5V

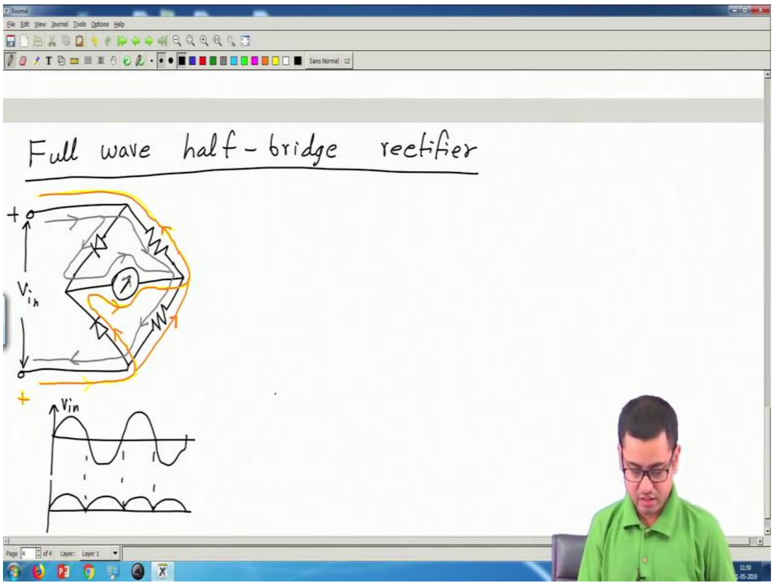
$\frac{V_p}{\pi/2}$ = Vm=5V

Vp = $\frac{5\pi}{2}$

RMS (Vin)= $\frac{V_p}{\sqrt{2}} = \frac{5\pi}{2\sqrt{2}}$

So, if you calculate it. So, this is this will come out approximately, do the calculation with a calculator I do not have a calculator. So, I guess this will come out to be something like this 5.5 volt RMS ok. So, this is the answer ok. Now let us talk about another circuit another full wave rectifier.

(Refer Slide Time: 21:17)



This is also very similar full wave half bridge rectifier ok. The previous circuit which we have sinned ok. So, this is called full wave full bridge. So, this is full bridge full wave full bridge ok. Now the one that we are going to see is very similar let us make it. So, let us make a square fore arm say, I will give the input here and say the meter will be connected across the other two terminals ok.

So, this is the input, now let us find out the direction of the current which I want how the correct the direction of the current should be. So, say I one in the positive cycle current should flow like this ok, put an arrow and say in the negative cycle, I want the current to flow like this, again left to right through ammeter ok. So, if this is what I want now I will put diodes. So, here I need the diode like this, then here I need the diode upwards ok, but in these two branches I will not put any diode, but I will just put some resistance ok.

So, this is why its called half bridge, because I am using diodes only for one side of this bridge or this square I mean structure. So, I am using doubts I mean half number of diodes instead of four diodes I am using two diodes ok, but. So, its called half bridge, but this is still a full wave rectifier because why let us analyze this circuit once again. So, in the positive cycle when this is positive, current will go from here it will go like this and like this, but a part of current can also flow in this branch like this. So, maybe I join them ok.

So, in the positive cycle current goes like this here and then it has two paths one like this through the meter and through the other resistance going back to the other terminal, another path is through this other resistance like this ok. So, it has two parts in the positive cycle and through the meter current is flowing from left to right. And in the negative cycle in the negative cycle current is flowing from here its like this, then it has two parts one through the diode and then through the meter let me use a different color for greater visibility.

So, in the negative cycle that other cycle current is going like this, it has two paths through the this is through the diode and the meter its going back and it has another path which is like this, it goes directly through this resistance and back ok, but through the meter current is always unidirectional. So, current through the meter is always from left to right. So, the wave form of say or the voltage if I call across this meter will always be full wave rectified. So, let me draw V m V in fast which is sinusoidal and then let me draw V m, V m will be like this always ok. So, that is why its full wave rectifier, but its half bridge because we are using diodes only on one half of one side of this bridge ok. So, this is another circuit one can use just for your knowledge.

And so, one important fact here is that this the. So, say in the in one cycle current is flowing partly through this resistance not its not going completely through the meter ok. So, the sensitivity of this scheme will be less lesser compared to the full wave rectifier because for full wave rectifier entire current must flow through the meter here part of the current is bypassed through this resistance. So, less current comparatively less current flows through this meter and this will have lesser sensitivity, but it has some other advantages in some I mean we are not going into that detail in this course, but it has some other advantages in which we are not going to discuss now. If time permits we will discuss it later.

Thank you.