Electrical Measurement And Electronic Instruments
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Lecture - 14
Ammeter – II

In this video we are going to talk about multi range ammeters and range changing of ammeters ok, suppose ok. So, before that let me define a term.

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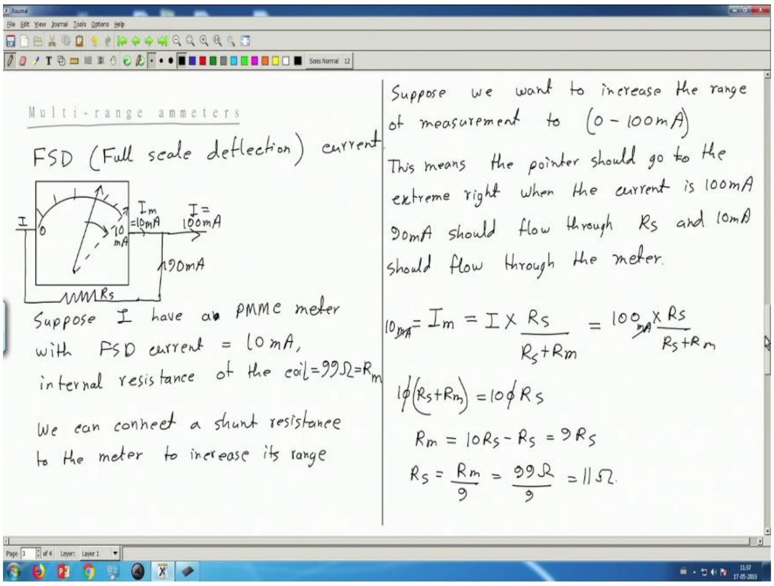

So, the term is called FSD a current of ammeter, FSD stands for Full Scale Deflection current ok. So, by this we mean the current that will cause the pointer to move to the extreme; extreme; extreme right hand side extreme position so, that current is called the FSD current. So, if I have a meter the current that so, the current I that causes this pointer to move to the extreme on maximum value ok. So, at this position that current is called the full scale deflection current or FSD current of an meter.

Now suppose I have an PMMC meter with FSD current equals say 10 milliampere and say the internal resistance of the coil is also known to be say take it 99 ohm as an example ok. So, now, if I connect this meter and pass 10 milliampere current through this. So, if I pass I equals 10 milliampere then the pointer will come to the extreme right position here. So, therefore, on this scale I can mark this point as 10 milliampere, this side I can mark as 0 milliampere 0 0 ok. So, this is the 10 milliampere marking on the scale.

Now suppose I want to measure current which is say 100 milliampere or which is close to say 1 ampere, now can I measure that current with this meter, what will happen if I pass 100 milliampere current through this meter. Firstly, the pointer will of course, get to it is maximum possible position and will get stuck ok. So, if this is my 10 ampere region 10 ampere marking then I if I pass 20 ampere 20 sorry milliampere current then also the pointer will come here, if I pass 30 milliampere current then also the pointer will come here, because the pointer cannot move any further.

The meter can also get damaged because of excess current that is a different issue, but also we cannot measure more than 10 milliampere current directly with this meter, but we can do small alteration in the this meter. So, that we can easily measured 100 milliampere or 1000 milli ampere currents with this meter any value of current greater than 10 milliampere we can measure.

So, what is that alteration so, we have to connect a shunt resistance ok. So, suppose you want to increase the range of this meter we have to connect a shunt resistance. So, we can connect a resistance in parallel in shunt to this meter. So, we can connect a shunt resistance to the meter to increase it is range how?

Because if I connect a parallel path to this meter with suitable resistance or conductance then it is possible that when I pass say 100 milliampere current through this say if I pass 100 milliampere current, then maybe a most of it maybe 90 milliampere will pass through this parallel branch and only 10 milliampere will pass through the meter and the 10 milliampere a current is good enough for measuring with this meter.

So, we can bypass we can give a parallel route for the excess current to flow through this shunt resistance. Now what should be the value of the shunt resistance or this parallel resistance? So, if I call this R s, what should be the value of R s? Suppose we want to increase the range of measurement to 0 to 100 milliampere. So, with the actual meter we were able to measure only 10 milliampere ok, because only with 10 milliampere current the pointer goes to the extreme right, but now we want to measure currents between 0 to 100 milliampere it is a larger range. So, then what should be the value of this shunt resistance.

So, basically this means the pointer should go to the extreme right when the current is 100 milliampere. But the pointer goes to the extreme right when this current is 10 milliampere;

that means, 90 milliampere current must be bypassed through this branch R s. So, therefore, actually we will have so, here the total current will be 100 milliampere, but only 10 milliampere is flowing through the meter and remaining 90 milliampere should flow through this parallel path ok. So, 90 milliampere should flow through R s and 10 milliampere should flow through the meter ok.

So, now, if we know that the internal resistance of this meter is call this is 99 ohm is given call it R a meter resistance or call it R m, m for meter. So, this is the meter resistance and this is R s and the total current is 100 milliampere. So, we can write that I m that is this current meter current only 10 milliampere. So, this will be given as I this is I 100 milliampere multiplied by according to the current divider rule we can write

$$I_m = I x \frac{R_s}{R_s+R_m}$$

$$I_m = 100 \text{ x } \frac{R_s}{R_s+R_m}$$

$$10(R_s + R_m) = 100R_s$$

$$R_m = 9R_s$$

$$R_s = 11 \; ohm$$

So, with this value of R s we can change the range of this meter to 100 milliampere from 10 milliampere. Now let us take another example let us continue this problem ok.

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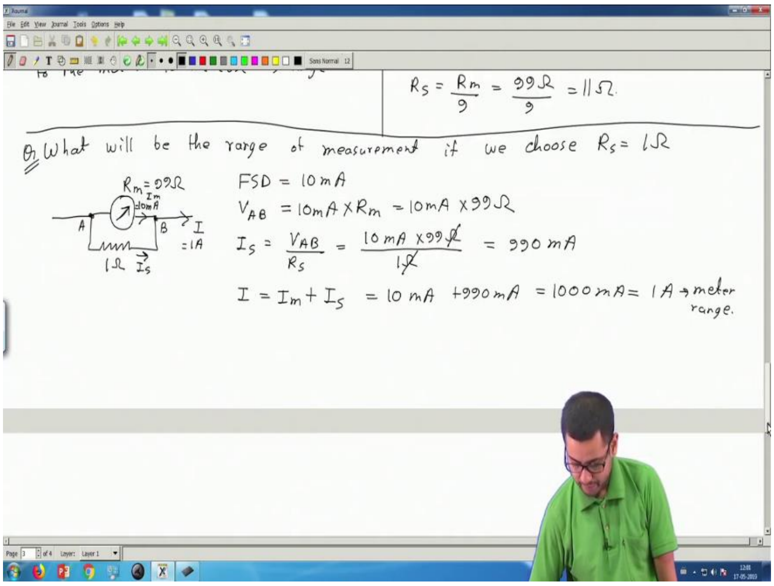

So, what if so, what will be the range of measurement if we choose say R s equal to 1 ohm ok. So, now, this is my meter and we know R m meter resistance is given to be 99 ohm we are connecting a 1 ohm resistance in parallel so, what will be the range of measurement ok? So, now, the full FSD current is given to be 10 milliampere for this meter it is given here so; that means, when this current is 10 milliampere the pointer will reach it is maximum position extreme right side ok.

And if this current is 10 milliampere then what is the voltage between these two points call this A and B. So, V AB will be equal to this current 10 milliampere multiplied by R m meter resistance which is 10 milliampere multiplied by 99 ohm so, this will be the voltage between these two points. So, therefore, what will be this current call this I s shunt current then I s will be V AB voltage divided by R s which is known to be 1 ohm. So, this we can write 10 milliampere multiplied by 99 ohm. So, this is V AB divided by R s; R s is given to be 1 ohm ohm ohm cancels. So, I s becomes 99 into 10 990 milliampere so, this is the shunt current.

Now what is this current I? I is nothing, but this current 10 milliampere call it I m meter current plus I s this is the shunt current so, this is I m ok. So, this will be 10 milliampere plus 990 milliampere is equal to 1000 milliampere or 1 ampere ok. So; that means, when this current is 1 ampere the meter indicates full scale deflection; that means, the meter range is now or turn to 1 ampere so, this is the meter range ok. So, this is how we can change the range of an ammeter and therefore, we can actually if you have a meter with FSD current 10 milliampere we can measure any current larger than 10 milliampere by using suitable shunt resistance.

Now suppose you all have seen maybe in your lab ammeters which has multiple range which has say multiplied terminals and depending on the range of current that you want to measure you connect the wires all across the suitable terminals or it may have some knob with which you can change the range of measurement, how is that done.

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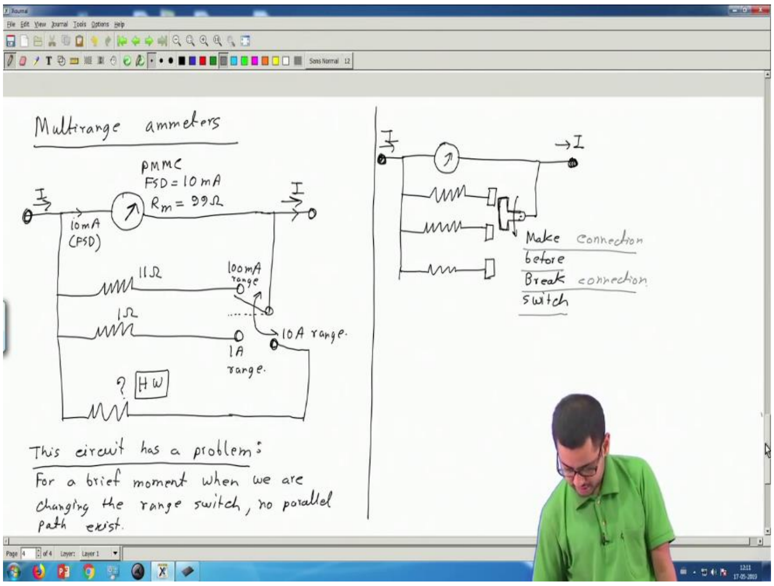

Basically so, let us talk about multi range ammeters ok. So, what we can do we can take meter say this is a PMMC meter with FSD say equal to take the same value as before 10 milliampere and R m meter resistance or call resistance equal to 99 ohm. Now if we connect say 11 ohm resistance ok, then as we have seen when this current is 10 milliampere; that means, we have full scale deflection then this current becomes 100 milliampere.

And if you had used at different resistance so, let me disconnect it and let me connect say different resistance and say if this is 1 ohm then when this. So, if I connect this like this, then when this is 10 milliampere this will be 1000 milliampere or 1 ampere so, this will within 1 ampere. So, now, we can use a switch to change between this resistances so, what we will do, we will take a switch which you can either connect to this resistance or this resistance and depending on where you connect your mail at range of the meter will change. So, if I connect it here so, this is this point I mark it as 100 milliampere range and this point this position is for 1 ampere range so, this is a multi range ammeter ok.

So, we and we can connect more resistances if we need higher rangers. So, if I need say another range of say 10 ampere what will be the value of this resistance ok. So, let me put this as an small exercise for you or homework, find out the value of this resistance if I want to have a 10 ampere range so, this is multi range ammeter.

Now we can have another type of a circuit for multi range ammeters, because this circuit has a small problem what is that problem. The problem is suppose I am measuring some current which is flowing which is I and I and then during the measurement I find that the chosen range is not suitable therefore, I am changing the position of this switch ok.

So, let me draw this here so, I can change the position of this switch. So, I can connect it here or here or here, but you see that when I change the range say I change the range from here to here 100 milliampere to 1 ampere. Then for a brief moment when the key is moving when the key is here the this is connected neither to this resistance nor to this resistance. So, this path is completely open so there is no parallel path for a brief moment when I am changing the switch position. So, for a brief moment when we are changing the drain switch no parallel path exist.

So, therefore, this path gets disconnected for a brief moment and then the entire current should or must flow through the meter through the meter only and this current maybe is a of a higher value than the FSD current or the allowable current through the meter and then the meter may get damaged, because for a brief moment there is no parallel path ok. So, the meter may get damaged due to high current in this brief a brief period of time ok.

So, one solution is this so the solution is very simple one solution is this if I so, use a different type of switch which is called a make before break switch. So, these two are the terminals of the meter through which the unknown current I should entered and leave. And now see that the switch is so, that it when it is connected to this it is ok, but then when I am changing from here to here, this will touch this resistance first before it disconnects from this is a switch ok.

So, this is schematic diagram so, basically this is a flat I mean longer switch. So, that this touches the new resistance first before getting disconnected from the previous resistance.

So, this is called a make before break switch ok. So, we can say also so, this is like make connection before break connection switch. So, this is one solution so, this is a one solution. Another solution is called art on shunt so, let me so, another solution another circuit which is like this.

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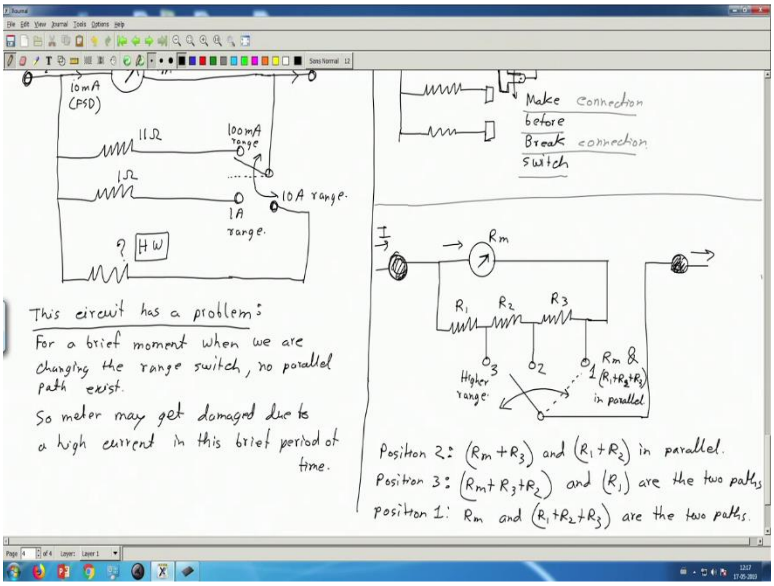

So, if I have my meter with internal resistance R m I will connect a set of resistances like this and then so, now. So, I have a set of resistances call them R 1 R 2 R 3 this as registers R m this is the meter the call resistance and I have a switch this can connect either to this terminal or to this terminal or to this terminal. So, this is a switch and this is the final inlet and outlet of the meter.

So, now say if I connect the switch to position 1 call this position 1 if the switch is here ok, then the current that enters I will get distributed in 2 hubs, one goes through the meter like this ok. So, it comes like this and goes out another half goes through the set of resistances R 1 R 2 and R 3 and then goes out so, now, we have so, for this position we have R m and R 1 plus 2 plus R 3 in parallel ok. So, part of the current goes through this 3 resistances and the part goes through the meter ok, now this is for position 1.

Now for position 2 so, for position 2 if I connect this switch here; so, I have this R m and R 3 in series so, part of this current goes through R m and R 3 like this ok, R m then R 3 like this and part of the current goes through R 1 and R 2 and then out ok. Then so, for position 2 I have R m and (R m + R 3) and (R 1 + R 2) in parallel this is a position 2 and for position 3 see if I connect this switch here then I have R m R 3 and R2 in one path and R 1 in the other path ok. So, I have (R m + R 3 + R 2) this is one path and R 1 alone so, these two are the 2 paths ok.

So, let me also write for position 1. So, for position 1 we have R m alone and 1 2 3 together so, these 2 are the 2 parts ok. So, you see that if I connect this meter to position 3 then the shunt path or the parallel path parallel to the meter is of a lowered resistance value compare and this or the other path meter path has (R m + R 2 + R 3). So, if I connect it here more current is bypassed so for position 3 more current is bypassed from the meter.

So, this is a higher range so, position 3 is higher range and position 1 if I put this switch here then the shunt resistance is now higher (R 1 +R 2 +R 3) compared to R m which is alone ok. So, this for this position more current goes through R m less comparatively less current goes through the parallel path. So, this will be a lower range. So, this is the lower range.

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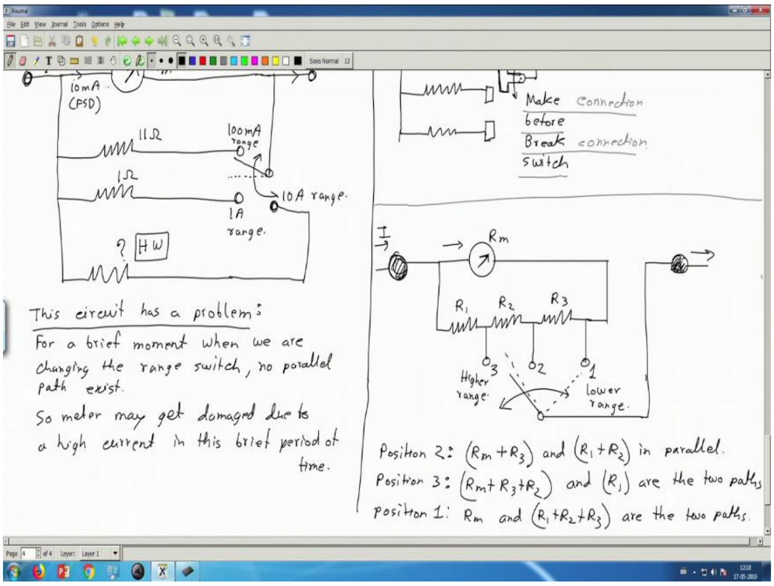

Now so, this is another arrangement and observe that when I change the position of the switch ok. Then even if the which is say somewhere in between it is not connected to any other of terminals no problem I am no problem from the perspective of the meter, because then the circuit is completely open there is no path for this current to flow at all. So, the meter can never get excess current unlike this situation where if the switch is here it is not touching any of the parallel paths then all the excess current will flow through the meter.

In this case the circuit is broken completely so, the current I will stop when the switch is here between two terminals and therefore, excess current does not flow through the meter. So, from the perspective of meter the meter is more safe so, this is called at an shunt and so, this is another arrangement one can have and one can compute the values of these resistances depending on the required ranges. So, we will take a problem in a tutorial class where we will calculate the values of this ranges of this of the values of the resistances to get suitable ranges ok.

Thank you.