Experimental Physics I
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Lecture – 59
Devices around us

So, we are almost at the end of this course. It is a course of 60 lectures. So, in last two lectures, I will discuss some general devices, instruments tools around us to test knowledge whether whatever we have learn in this course whether it is useful to understand the surrounding of us. So, this is the 59th lecture.

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So, this Device is around us. So, in this lecture I will discuss about the principle of electric fan, grinder and drilling machine. So, these are the instruments every every house have. So, we use electric fan in every house, we also use grinder is curve is basically mixture. So, that equipment also use and drilling machine in nowadays to whole wood or this wall etcetera; so, we use drilling machine.

So, what is the working principle of this instrument that I want to discuss; mainly to test whether we can understand the principle of this instrument with our knowledge gathered in this from this subject.

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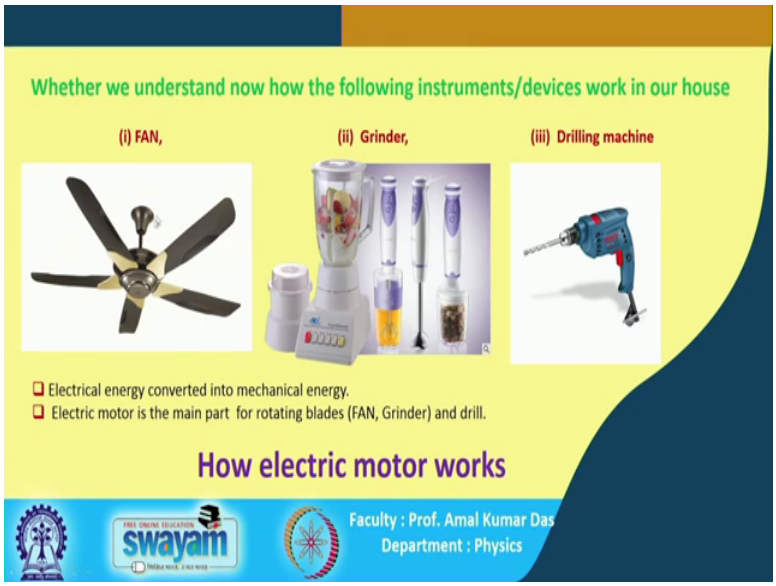

So, , these are very common instruments or devices in our house – fan, grinder and drilling machine. So, this machines are basically here this electrical energy is converted into mechanical energy basically we use current and then we get the mechanical work for these three cases. There are many other examples; so just I have picked up three. So, similar instruments are used in many other cases.

So, here for these three instruments this common this electric motor is the main part for rotating blade, blade of this basically fan, blade of the blade of the grinder and drill or rotating drill of this drilling machine, ok. So, in all three cases you see this rotation of blades and drill so, that we use for our purpose for getting air cool air in our room to mix the different kind of say vegetables or fruits or some other grains food grains to mix it we use this grinder and there also this basically rotating the blades and to build a hole or yes, mainly in this case we used to make hole in for different purposes.

So, this is the here this rotation. So, main things is something is there in all three cases which rotate this blades and drill, so, what is that? So, that is basically electric motor, ok. So, so this working principle of all these threes are basically how this electric motor works. So, if you understand that one so, then basically we will be able to understand the function of this devices. So, how electric motors works? Ok.

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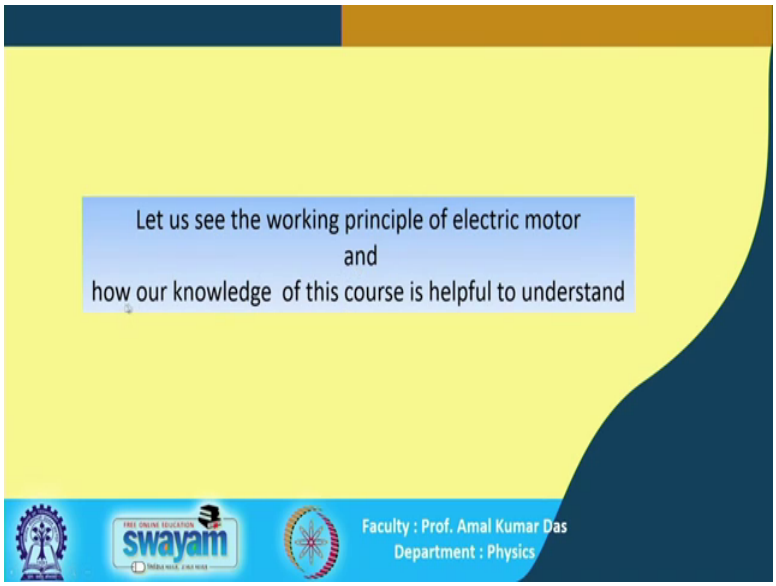

So, let us see it as I told this working principle of electric motor and we want to test the how our knowledge of this course is helpful to understand.

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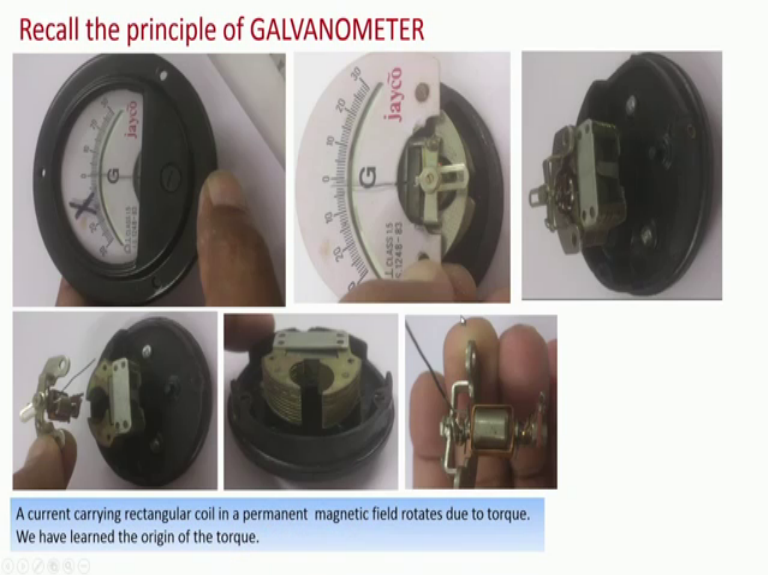

So, I have shown this one in this course. So, galvanometer and I opened it and we have seen that there is a permanent magnet. It has it is a it has permanent magnet and a rectangular coil and a rectangular coil in the permanent magnet. So, basically an rectangular coil, a current carrying rectangular coil in a permanent magnetic field and we

have seen his then this coils rectangular coils it rotates and it rotates due to torque and we have learned also the origin of this torque, right.

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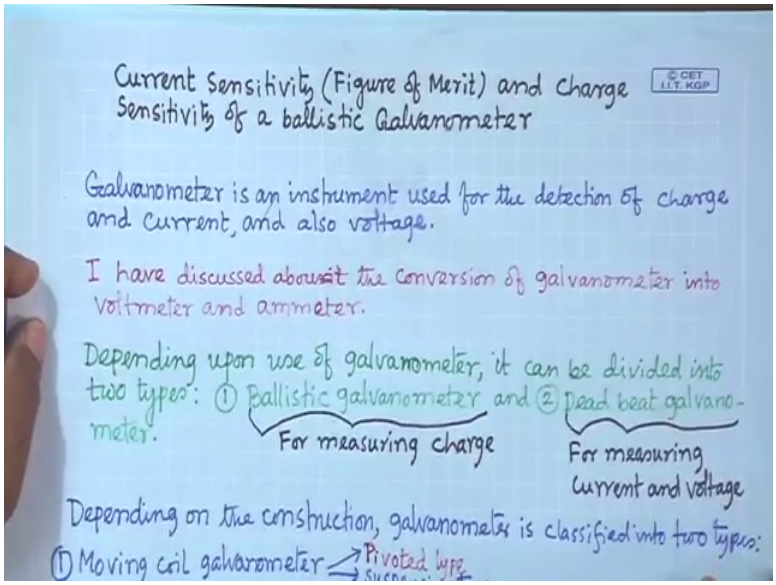

So, you remember that I have discussed this experiment we have demonstrated we have demonstrated this current sensitivity current sensitivity and charge sensitivity of a ballistic galvanometer and there I have discussed. So, here just I want to remind you that what we have learned from our experiment.

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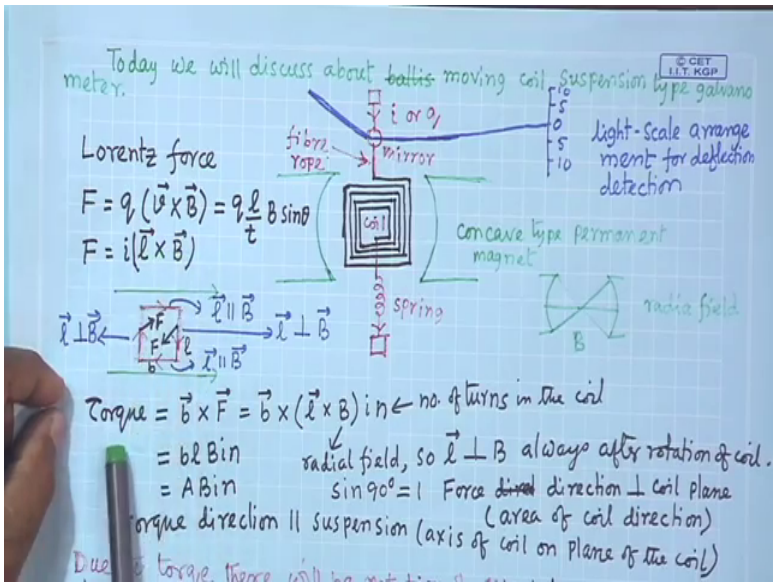

And, that I have discuss the theory part of this experiment that basically this you have a magnet permanent magnet it gives magnetic field and your rectangular coil is in a in this uniform magnetic field and this coil it current passes through this coil then this coil rotates. And, to restore this restore this rotation so, we have used this basically either this torsion or the this some cases we use spring some cases we use this phosphor of fiber rope, ok.

So, this for this basically for restoring torque and because of this restoring torque it basically oscillate, or it just deflect and deflects or rotate and stay at a equilibrium position. So, there is rotation if this restoring part is not there then it could rotate it could rotate all the time it could rotate inside this permanent magnet,. So, here we have learnt that when current flows through this rectangular coil so, these two arm in one arm current is say up and then another arm current is down, ok.

So, this current carrying conductor in a magnetic field it will fill the force that force is f is equal to i l cross B and then corresponding torque depending this difference between these two, so, b cross F, right. So, these all things we have discussed and we have learned, ok. So, in this situation torque works on this coil and torque direction it will depend on the direction of the current and direction of the magnetic field, direction of the current and direction of the magnetic field, that is very important, ok. So, so this that is what we have learned from the experiment demonstrated in this course.

Now, this knowledge basically this knowledge is useful to understand the working principle of the working principle of the fans, grinder as well as this drill, ok.

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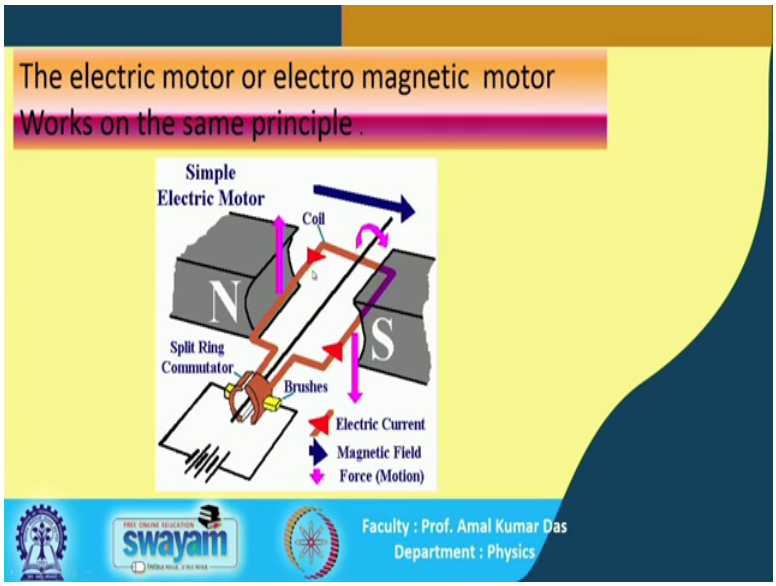

So, , with this knowledge let me let me try to explain this principle of this electric motor. It is also called electromagnetic motor, ok. So, this is the schematic diagram of this electric motor. So, in electric motor there is a permanent magnet. So, these two pole this north pole and south pole. So, magnetic field will be between these two gap, between this gap. So, magnetic field is nothing, but the lines of force right per unit area.

So, so, this magnetic field, say in this direction north to south. So, now, here there is a coil there is a coil. Now, in this coil if current flows if current flows this way depending on the direction of current so, this torque direction; so, force direction in this direction on this arm and current in opposite direction here. So, force direction will be just opposite direction, ok. So, then between these two distance so, the distance so, this force into this distance cross this distance is basically torque, it will act so, along this axis.

So, this force direction this torque direction will be this axis; that means, this coil will rotate. It will rotate because there is no because there is no restoring force on it. We have not use the spring or the fiber rope as we used in case of galvanometer. So, that their purpose was different. So, here if such restoring force is not there so, then it will rotate.

Now, problem is you see when it will just rotate by 180 degree so, this arm will come here and this arm will go there. Now, but current direction will remain same, right. So, when this arm is coming here so, current direction will be downward and for this arm when this arm will come here so, current direction will be upward, ok. So, then this

torque direction will be just opposite, ok. So, then it will start to rotate in opposite direction, but in case of fan or this drill you have seen this it rotates in the same direction. So, to get the rotation in same direction so, there is a arrangement here. It is called basically here you see this commutator you know commutator commutator is used to change the direction, right.

And, so, here. So, this is the shape of this commutator you know this wire is connected with this part this half and this wire is connected with the end of the other end of the wire is connected to the this half, ok. So, now, actually this is rotating this is rotating. So, when it will rotate so, these work will come here and this electrical connection is taken from this paired kind of thing that is called brushes. So, this is the is basically from source this connection is given to the to the to the circuit. So, that is it is called this arrangement is called brushes, ok.

So, when it will rotate so, this will be connected with this one means positive one and this will be connected to the other one means negative one. So, as if the polarity will change. So, that means, direction of the current also will change. So, direction of the current will change means when it is coming here so, instead of downward current will flow upward. So, that means, I will get the same similar condition as same condition as now, ok.

So, so, now, if I get the same condition so, this torque direction will be same remain same because this arm is coming here and current direction is just changing. So, this downward will be upward so, we are getting this condition and the rotation will continue in same direction, ok. So, here what we are seeing this the same rotating principle as we have seen in case of galvanometer, so, in motor electric motor actually this the principle of the electric motor is same as the principal of the not same I will tell they similar same knowledge is used here and we will get continuous rotation. So, there are basically this is the main I think easy way to understand.

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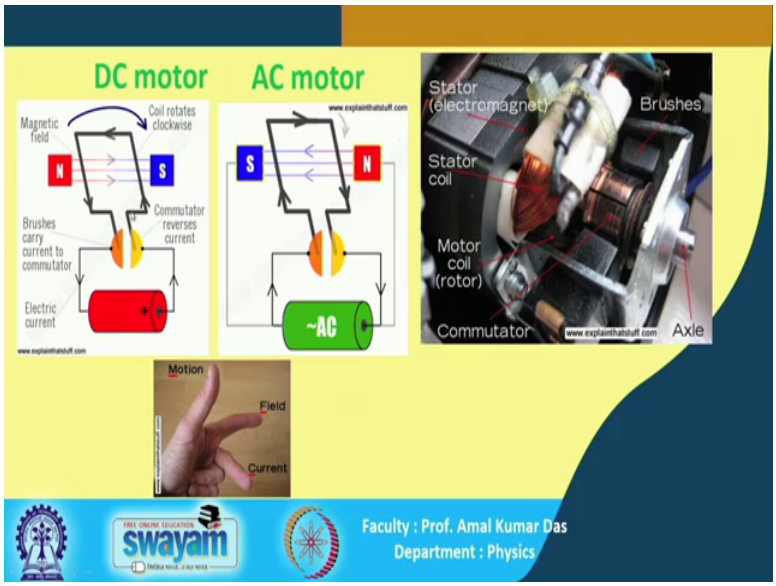

So, there are DC motor and AC motor. So, in case of DC motor actually whatever I explained there so, this you have permanent magnetic and this field direction is all the time in this direction. Field direction is all the time in this direction, and this polarity changing using the commutator reversing the current polarity changes. So, we will get the rotation of this coil in same direction.

So, now, you are in case of fan or in case of this motor this what it is called this drill or grinder so, whatever blades that blades with axial with axial these blades are connected are fixed with this coil basically. So, coil is rotating means that axial is rotating means these blades are rotating. Whatever we see in case of fan so, that is basically this rotation of the blades is basically this rotation of the axial, rotation of the axial or rotation of the of the of this coil because they are attached with this coil, ok.

Now, this is the DC motor, ok. Now,, but in our house you know this or electricity is basically AC. So, it is so, use AC current see in case of AC ah; so, there instead of permanent magnet to use electromagnet, ok. Electromagnet you know this from coil if you pass current through the coil. So, you will get the it will act as a magnet and you will get electro magnet.

So, two coil if you use so, they will be south and north pole. Now, this south and north pole of these two coil. These two coils have two faces. So, one face will be south pole another face will be north pole. So, , here two coils; so, here we are showing this south

pole and north pole in other side ok, but not this north pole of the same coil. So, here this north pole or south pole of one face and this other face will be north pole or south pole, ok.

So, here we used this electromagnet and AC current is given to this electromagnet; that means, AC current you know this is first half is positive and second half is the negative. So, so, for a complete cycle basically half will be the direction of the current of a table. So, for other half it will be just in opposite direction. So, that is why this periodically half period in half period this pole of this of this electromagnet will change, ok. So, so here basically we are changing the direction of the field, ok.

So, now, now here instead of so, what will happen. So, say current is flowing current is flowing through this through this wire and this is also AC current this is also AC current. So, what will happen? So, for a particular position you see this is north and this is south and in that time current is flowing this up and this is down, ok.

So, whatever the torque direction you will get now for second half this is south. So, field directionally changes and also current directionally changes here. So, whatever upward was upward was there. So, now, it is downward. So, field and current; so, force you have seen this i l cos B. So, if current direction changes and field direction also changes. So, minus minus into minus, so, it will be plus. So, effectively that direction of the of the torque will remain unchanged. So, it will rotate in the same direction, ok. So, this is the AC motor, ok.

And, this is the real picture. So, here you see this I showed you this commutator in here this commutator this split ring commutator, ok. So, it is two. So, here basically I think let me go to the next one. So, here there is a problem. So, there will be jump basically here changing will be jumping from one state to another state, ok. So, because here this current is changing is not it is amount of the current is varying, ok. It is positive current direction of the current will be in one direction what is magnitude changing, ok.

So, this motion of this one will be affected it will be it will also vary like following this current variation. So, to so, these things will not be smooth. So, rotation will not be smooth. So, to make this rotation smooth instead of these two coils in reality it is there are many coils are used, and depending on the number of coil. So, here this brushes and this I think brush will be two and this let me go to the here, yeah. So, this commutator

here so, this splitted that part is one complete ring will be splitted with many division, ok. So, each one will be connected with the each set of this electromagnet, ok; so this electromagnet nothing, but the coil, ok.

So, I think I if I show the, but it is not there I had another picture anyway, but it seems yes. So, it is not there. So, here I think it is a divided into four it is the for four coil. Here for two coils this two, ok. See if you have four coil, so, there will be four, but in reality this number of coils here use many number of coils are used. So, this will be this commutator this half it is it is number of divisions will be more whatever. So, this is the this arrangement is nothing, but the two make the rotation smooth, ok. But principle is same. So, how smooth you want so, depending on that how many how many coils you will distributed over the over the region.

So, here this axial is will rotates this axial is rotate is attached with the this kind of rectangular coils and these rectangular coils in a that is called rotator in a magnetic field. So, in case of AC there is the electromagnetic field and that is that is fixed, either permanent magnet or the coil. So, they are permanent they are static. So, they these are called stator coil and these the called motor coil inside of this one and which is attached with this axial, ok.

So, basically this coil will rotate rotor coil will rotate motor coil rotor you will rotate. So, that means, this axial will rotate. So, on this axial these blades are blades or the drills are fixed connected. So, this whatever we are seeing this fan this working drill is working it is basically that is a rotating that is because of this electric pole and principle is similar of the galvanometer whatever we have seen and that experiment we have done, ok.

So, I think this is the just application of our knowledge from this course whether we can understand we can understand the principle of the devices around us. So, in next class I will discuss another example (Refer Time: 24:48) instrument which is used in research. So, I will discuss in next class.

Thank you, for your attention.