B. ARCHITECTURE

BUILDING SERVICES – II (AR6511)

ELECTRICAL & ELECTRONIC SYSTEM ABOUT ELECTRICAL WIRING SYSTEM

Lecture - 1

Basics of Electrical Theory:

To start with we have to understand with some basic electrical theory. Like we know that electricity is everywhere we see lights are on our way cooks our food so where is it coming from. So what is electricity basically it is the movement of charge so the charge is moving the positive charge is moving to the negative charge. This flow of electricity charge is known as electric current. Now when we say electric current you have two types of current direct current and alternate current, so direct current is one which flows with the constant voltage polarity if you see this picture here so there is a constant flow and there is a one polar direction, In Alternating current it will be changing periodically that is why it you see the curve here so some times this will be half on top or half down so also its polarity will be changing. So these are the major different direct current and Alternating current.

So when you see a short history we know about Thomas Edison and Alessandro voita are pioneers in DC current. So they wrote much of electrical history as we know but when we start using DC the transmission was not efficient to transmit from one place to another as DC current.

So there another person Nicola tesla he invented the Alternating current electrical system. So when you have Alternating current it is possible to produce high voltages that means you can change the current and like whenever you want you can increase the voltage or reduce the voltage depending on the usage. So that is why in most portable devices we use DC current and when you see Power plants or large power system they produce Alternating current.

When we talk about electricity you need a electrical circuit to move this movement of charge. This flow of electrical charge you need a pathway which is made of wires, through these wires we create a electrical circuit's we have a electrons which goes into a light bulb, so what happens is it gives a power and makes it to work. Like in bulb it will increase the heat inside the filament and the filament will glow that is what we get is light.

Laws of Electric Circuit:

When we talk about electrical circuits we have two major laws one is Ohm's law and Kirchhoff's laws without this two laws there is no circuit calculation and anything. When you take Ohm's law basically V=IR and Kirchhoff's laws you have two things Kirchoff's voltage law and current law. Kirchhoff's voltage law deals with the conservation of energy, Kirchhoff's current law deals with conservation of charge.

When you take Ohm's law V=IR when V is the voltage, so voltage is the difference between the charges of any two points and I is the current the rate of speed in which the charge is flowing and the resistance is how the flow of charge is been resisted by the materials. so voltage when you take it is the product of current and resistance. So the strength of the direct current as per this law is directly proportionate to the potential different, so when there is a difference in the current it is directly proportional but when u take the resistance it is inversely proportional. So this is the measurement that we use to work the charge between unit of the charge is passing between two points. Then we have Kirchhoff's voltage law it says that any closed loop (the circuit will be always in a closed loop) so if it is in a closed loop the sum of the voltage drops is equal to the sum of the voltage rise. When you talk about circuits and charges flowing there is going to be some loss and some gain. So per this voltage law they say whatever voltage drops will be gained in some other place. Then you have the current law this is the sum of the current flowing into any point is equal to the sum of the current flowing out, so whatever current is going to one point it is going to come out, so there is going to be no loss so that is what the current laws says.

Basic of Electricity:

Now other things we have to know about the basic of electricity is single phase electricity and three phase electricity. So have single phase power and three phase power at our homes so what is a single phase power does? It actually provides alternating current in which the voltage all travels in the same pattern if you see there will be only one single curve that is going on. So this is very common when the load is very less, that is only for lighting and heating if you are going to use the current then the single phase electricity will do and a few motors up to 5HP you can use a single phase electricity. When it comes to three phase electricity you can see that there is a three different types of waves you can see here, this is because when the power is being generated you undergo a special method like what happens is there is conductors which is producing the power, generating the power each conductor will it reach its top energy but all the three conductors will not do it at the same time each will go in a order manner in a pace manner.So when one is at the bottom the other two would have already gone through it will be going in a cycle,so what happens is at any point of time we will be having a high voltage will be passing through.So what happens is this method will have the energy also coming in three lines so equal voltage will be there and equal frequency will be there.So this will produce higher voltage so you can power up higher motors or equipments.So that is why we use three phase electricity paticulary have A/Cs at home you definetly require three phase electricity so that is the reason because three phase electricity can support higher voltages.

Then we come to earthing the next important basics of electricity is earthing.Earthing is, it is connecting any non-current carrying conductor part,so in an equipment there is always some part willnot being conducting current but it is present in the but it is also conductor of electricity it is present in the equipment. So what happens that is a loose connection so that has to be grounded that is what it is called as earthing.So with general mass of earth so that the immediate diacharge,so what ever current is passing through non-current carrying part of the system that electricity in that system will be discharge,if it is not discharge what happens is when we touch it or when use that appliance or equipment that current will pass on to us. That is what we call, we get electric shock when we touch certain appliances or equipments. That is because the non- current carrying conducting part of the equipment is not properly earthed. So when this

electrical shock passes through our body, very mild, it will not be severe. But sometimes it might lead to human life also will be the cost of it. So earthing is very important.

So how it is done?. If you see here, there will be a copper rod or something, that will be driven deep into the ground and that will be connected by reels of wire. That is called a conductor. Connected to the mains. So this rod will be put inside a pit, so that it is safe and also the area that is surrounding the rod , that will be depending on the soil condition will be modulated. So the solid copper rod is driven into the soil, usually outside the building and will be connected to the main electrical panel. This is what we do as earthing. This is what is basically earthing. But this earthing instead of the rod, we can have many types depending on the type of material we use, depending on the configuration of the material it is plate earthing or pipe earthing, rod earthing, strip or wire earthing.

So Plate earthing is nothing but you will have instead of a rod, you'll be seeing a plate you can see here. Instead of the rod you can see a plate. The other things are the same. There is just this plate. This plate you cannot use everywhere. The dimensions of the plate has to be 60cm by 60cm and the thickness should be 3.18mm, if it is going to be copper. If you are using galvanized iron it will be much thicker like 6.35mm thickness has to be there. So it is buried vertically in the earth, however you bury the rod in the pit. It should not be less than 3m from the ground when we use. So these are the sizes and how you bury it and what is the depth you are going to bury it will make the difference in different types of earthlings here.

Then you have pipe earthing:- Pipe earthing will be like the earthing rod will be replaced by a galvanized iron pipe. So again these earthing pipes are the same, is connected here to the conductor,. So this pipe will be a perforated pipe. So the length and diameter will be as per strata of 38mm in dia and 2m length will be there. So this is again placed vertically in a wet soil. So this is the common system we generally follow in an earthing, If we are doing an earthing.

Rock earthing:- is this is similar to pipe earthing but it is very cheap. It won't go into excavation. It means it is very closer to the surface of the ground. So if you take a copper wire it will be 12.5mm dia or 16mm dia. For galvanized steel it will be 25mm of GI pipe. So it is length of 2.5m is enough and the length of the embedded electrodes in the soil reduces the earth's

resistance to a desired value. So when you are doing this earthing, whatever material we are burying in the soil that is going to take up the electrical charge for which ever appliances that is not connected. So that is distributed to the soil. So the embedded electrodes will take up this and give away into the soil.

Now we have Strip Earthing:- Here strip electrodes will be used in this method. The strip will be 25mm by 1.6mm and it is buried at the depth of 0.5m. so if you see the cross sections and the depth of where you bury the electrodes or the earthing material is making the difference. The installation system makes the difference. So strip earthing is generally used in rocky soil where excavation is difficult. So if there is going to be rocky soil you can just drill holes and you can insert it. You cannot excavate the area.

Now when it comes to ISI specification, this earthing has to follow some ISI. Generally ISI is a certification mark, is given for industrial products all over India. So for earthing we have to follow this IS3043 1987 Code Of Practice for earthing. So when you do the earthing based on this code of practice, then it is said to be an ISI specified earthing. So this is mandatory for products like electrical appliances.

Now as per the specification this electrodes should be placed at least 1.5m from the building that is away from the building, outside the building at least 1.5m. The earth wire and the electrode both should be of the same material. You cannot use different materials. The minimum sectional area has been said like 0.02 square inches and not more than 0.1 square inches. The size of the earth conductor should not be less than half of the section of the line conductor. So you have earth conductor and line conductor that size has to be followed. Again the wire that is taken through the GI pipe should be 12 around dia and at least 32mm length of the pipe should be used above ground surface. When you have loose earth, you mix coal and salt together as a mixture and that should be filled around the excavation pit or trench that you have for the earthing. So the earth wire connected to the electrode should be run along the whole wiring system that has to run, it not only for the earthing part.

Electrical Wiring System:

Now coming to wiring, electrical wiring is the main, only way we can distribute the power to the entire building. So this also helps us to distribute it in a perfect manner and economically we can do it. In wiring when you say, the state electricity board whoever is current to our premises, it will come and stop outside our building. From the building we have to take it inside our building and to various areas of the rooms and to various floors. That is done using the wiring system. So the customer has to take the connection from the point where the state electricity supply board has stopped to the main switch board. From the main switch board it is distributed all over the building.

Now when you take up this wiring system you have many types again. You have cleat wiring, casing wiring, batten wiring, conduit wiring and concealed wiring. Various methods are being applied here.

When you take cleat wiring, porcelain cleats are used. This also can be of wood or plastic. These will be fixed to the wire. The holes that you see here, screws can be used and they can be fixed to the walls and it is fixed at regular intervals. There is a gap of 0.6m should be there between each cleat that you have fixed. The wires are PVC insulated cables that is the wires will be run through the gaps that you see here through the holes and thus the cleats support the wire. You see the cross section here, through the gaps wire can be passed through. So this is actually a very inexpensive method of wiring. But it is not suitable for home electrical wiring and it is also a very outdated method. It is a very old method.

Then you have a casing and capping wiring: - Here what happens is, you have wooden casing which has grooves will be used. The picture that you see here will show you that. This is grooves you see here. Inside this is the wire that is coming out. So these grooves will be there which will take up the wires where ever you require. This casing will be of a fixed length and parallel grooves will be there to accommodate the cables. This casing will be fixed to the walls and ceilings directly by screws and after placing the cables inside the grooves, it will be like having a base and a cap, so you will be closing it with a cap. So the cables will be covered. This is a very cheap form of wiring comparatively. So this is your casing. You might have seen these kinds of things, in olden houses where you don’t have a concealed wiring

you have to take a new wiring will go for this casing wiring. The disadvantage is that is has a very high risk of fire because it is open.

Now batten wiring: - this is like the insulated wires will run through straight teak wooden battens. There will be wooden battens fixed to the walls or ceilings and the wires will run along with it and clipped by using plugs or clips, brass link clips will be used. These clips that we are using to fix these wires should be rust resistant nails. So if you see it closer, these also you can see it in very older houses. So this whole length you will be having wooden battens, a piece of wood it is. The wires are run through this. These are the clips. So this is a very simple and a cheap method. It will take very less time to install because you just put the batten, take the wires and fix it. This is particularly they use it for installations, you cannot use it outdoor because the wires are not covered. It is exposed.

Now conduit wiring: - PVC cables will be taken through PVC conduit pipes or through steel conduit pipes. This conduit wiring can be classified as surfaced and concealed. So this is what a surface conduit wiring will look like. The conduits are seen outside and this is concealed where you don't see the wires you just see the conduits. Conduits are nothing but the pipes through which we run the wires. So when you take surface conduit, the pipes are run on the surface of the walls and ceilings. Now holes will be made on the surface of the wall to the distances and then this will be clipped like your batten wiring.

And concealed wiring what happens is they will cut through the wall and they will put the conduits inside and later on pull through it. Now this concealed conduit wiring is the most popular method for its aesthetic appearance we use that.

Now when you take conduit wiring you have two different types of conduit. Metallic conduit and non-metallic conduit. When you take metal it is made of steel. When you use steel it is very strong but it is costly. But when you take non-metallic you have solid PVC conduits, this is very flexible and easy to bend and easy to handle. When we say about wires, the wires are going to go all around the house. So we need to have drawing or we need to know where which wire is going. If there is going to be a fault we need to check these drawings and then we have to find the fault where it is and repair it. So for that we have an electrical wiring diagram. So the main role is to convey information and the connection of various devices and equipments,

how it is done. This information will provide a complete design or plan of the circuit or electrical installation and how you assemble various things. So when you take the different types of drawings basically you have a block diagram, circuit diagram and line diagram.

When you take a block diagram you see all the appliances and the fixtures are represented as blocks. So the main fuse is here. From there we have 3 SPST switches that is represented by another block. And from there it is connected to a lamp and a fan and a motor. So when it is represented as a block a very symbolic representation of how you are connecting. At the initial level you will have a block diagram.

Then you have a circuit diagram. In the circuit diagram you see you have a very clear line there of how the wire is being taken up. Here you will have certain symbols for representing the thing .this symbol represent duplex receptacle and this is a fluorescent lamp. There is a legend provided here. In the drawing you just use these symbols and we do the circuit. You know from where it goes through, the wire how it goes through.

Then you have a line diagram. This line diagram will be a more detail diagram where you see we have 3 different lines and again we have a legend here. This line 1 what it represents, line 2 representation, line 3 representation. Now this also show the various details even the switches detail you can see whether it is 1 way switch or 2 way switch, that is like whether the switch has to operate at 1 place. 2 way switch you have 2 switches at two different places and one appliance can be operated from 2 places. So the detail will be to that extent that the line diagram will be in very detail. So these are the 3 diagrams we have for any wiring diagram.

So what is a wiring diagram? - Basically it is a pictorial representation of the circuit. It shows the wiring between the paths, elements or equipments. It also gives detailed information as I told you about how to make the connection between the devices. It includes the relative position, arrangement of the devices and also terminals on the devices. Why we need a wiring diagram means, somebody else is going to do the wiring and somebody else is going to be the user. So the diagram will be like a stable to have for future references.

So in a wiring diagram what we will have is supplies and earth connections, control and signal functions, termination of unused contacts and leads, inter

connections, via plugs, blocks whatever you are using all those things can be seen in a wiring diagram.

We have something called electrical bus bars. Commercial and industrial distribution system if you take they have huge voltage of current to be distributed. So what they do is cables and conduits will be very costly to distribute these things, the cables are going to be very heavy or the no. of cables will be more. So the conduits will also have to be a bigger size. So what happens is we will end up with a very costly system. It is also time consuming to install all the conduits because it is going to be a huge installation. So for this we use bus bars. Bus bars will take up the work of cables and conduits and it will distribute the electricity in the building. So bus bars is a conductor that serves as a common connection for 2 or more circuits. So generally when you see bus bar will be like a copper conductor, high voltage will be generally passed through this. From this it is taken to distribution boards, from there it will be taken to individual places. So when it is represented in a diagram, it is represented as a straight line and a no. of multiple lines. This will run through the entire building in a code and from there you will take the different separate connections. That is what we call as branch circuits. These bus bars may be aluminum or copper.

Bus way is defined by National electrical manufacturers association NEMA, it is a prefabricated electrical distribution system. It comes as a whole set up. We are not going to set up anything in this. It comes as your whole setup. So this is your bus bar and it has various connections for institution. This is the housing which is going to be putting everything inside and there is an epoxy insulation also. So it is a prefabricated system and it also forms a protective enclosure. It also has a support material and a a housing. So how does this distribution system work with a bus way is, it is very easy to connect the various sections. It can be supplied to any area for building as I told you, generally when we plan it , it will be taken for the whole of the building along side the board and from there it will be distributed. When we use a bus bar instead of cables and conduits, it takes 35% of man hours for installation or if you want to change a bus way system. So many systems can be connected to a bus way system,it can either be a cable system or a conduit system.

Now when you take the types of busways, you have horizontal and vertical. Horizontal is used for industrial locations. It is used to power heavy

equipment, too many lights and air conditioning will be used horizontally. Vertically this is what I said, busway risers. So in high rise buildings it is going be very tedious to take up the wires to so much of the height. Bus bars will be very useful, if you place it in the grooves and take it up. So it is also used to distribute lighting and air conditioning loads.

Based on the level of electrical distribution, it can again be categorized, from the transformer you have something called MLVS busways, from the sub distribution to low or high tap of densities and lighting distribution busways.

Transformers to MLVS busways is very permanent thing. Like from the state electricity board it has come to our premises. From the premises it will be taken to the transformers, so from the transformers when you take it into the building, it is taken as MLVS bus ways. So here there will be no tap of points. Tap of points are points from where you can connect any appliances. So there will be no tap of points when it comes to MLVS bus ways. It is used for very short run, very short distances, where parallel cable will be very possible to do that. Generally it is 1,600 to 2000amps we use that. It is also to connect between MLVS and downstream switch boards, again from MLVS you have to go to switch board you can use this type of subways.

Now from sub distribution how are you going to take the tap of density? For mid-sized premises and small sites we use this type of a bus way. For industrial workshops with many machines, large supermarkets with heavy loads, they will use this type of a bus way. And if it is going to be very small sites like workshops with machine tools, textile factories there will be too many machines and you will need to many tap of points. So tap of points like I told you, power points or socket points, for that you will use this downstream. And also there will be many modifications and upgrades when your are having to many tap of points, so may be if you are going to change if there is going to be a textile factory they are going to change that particular or upgrading the equipment or machinery. So when they are upgrading the machinery, the tap of points might also have to change. So this modification and upgrading is easy when you are using bus ways. Dependability and continuity of service can also be done with this type of bus way.

Now when you come to lighting distribution, this bus way is purely when you are using lighting circuits. And there are two types designed for the suspension and where suspension is not there it is designed for lighting

fixtures. Designed for means you supply and support the light fixtures like industrial reflectors, discharge lamps or if you see in studios there will be an array of lights that will be suspended so there you will use light distribution bus ways. And this will be very rigid because the system is fixed and the tap of outlets will be for every 0.5m to 1m.

And if it is not designed also you have prefabricated cables system, so that you can supply all lighting systems. This will be like more or less you can have where ever you want you can use it the lighting fixtures. Generally you see this kind of thing in a false ceiling if you take an office or something if there is a false ceiling there you require you just fix the lighting the thing is very flexible. So the tap of outlets for this will be from 0.2 to 0.3m.