B. ARCHITECTURE

BUILDING SERVICES – II (AR6511)

ELECTRICAL & ELECTRONIC SYSTEM ABOUT ELECTRICAL WIRING SYSTEM

Lecture - 2

Power handling Equipment:

When it comes to power handling equipment, we can actually categorize into three areas- wirings and raceways, power handling equipment and utilization equipment. Wiring and raceways are the conductors and raceways of different types. This is what we saw in the last lecture. Power handling equipment are the transformers, switchboards, panel boards, large switches and circuit breakers. Utilization equipment's are the things that we utilize lighting, motors, controls and wiring devices.

Now when we see about transformers, it is a static machine. It is used to transform power from one circuit to another without changing the frequency. Generally, transformers are used to increase or decrease the alternating voltages in electric power applications. Now it is very essential for the transmission, distribution and utilization of alternating current of electrical energy. These transformers range from very large sizes to very small sizes. Particularly transformers are used when AC is being generated at very low voltage and when you distribute that from the generated area to the buildings and the place of need, the losses will be heavy. So there they use transformers to step up the voltage to a higher level and then it is being transported, transmission will take place. Then again, when it is coming to the buildings or where it is the place of supply, it will be again step down to usage level, like the usage level that we require for our buildings. So transformers, we

have various types of transformers and all the transformers depending on the usage and purpose we can use it in wide areas.

Another thing is your electricity meter. Everybody would have come across an electricity metre. It is a device that measures the amount of electrical energy consumed by a residence, business or an electrical power device for that matter. So what happens generally the service cable that is the cable provided by the State Electricity Board will be terminated at the meter cupboard. This will be installed in the customer's premises, it measures the electric energy, whatever is delivered, and this will be billed periodically, like monthly or twice a month it will be billed.

Then you have a circuit breaker. This is a switching device actually like a switch. It can be operated manually or automatically. Its purpose is to control and protect the entire electrical power system. It is to interrupt the current flow when a fault is detected. Fault in the sense in the electric circuit, when the power is been supplied to us sometimes the power might go very high. We say high voltage is there. Therefore, when it goes like that the high voltage might disrupt or destroy all the electrical or electronic appliances that is being connected or which is being run or when there is going to be a very low supply also you will not be able to use the appliances. So this circuit breaker in case there is a fault is detected, it will shut off the current flow and it will safeguard the appliances. So the circuit breakers vary from small devices to larger switchgear. Smaller devices we mean to say it will the size of a normal switch to large switchgear will be in the form of big handles will be there.

Coming to switch boards. Switch boards will be a single panel, will be looking like a panel in the sense it will be like a bureau at home. It will be something similar to that, it will be very huge, and multiple panels will be assembled together depending on the requirement or whatever is going inside the switchboard. Generally, in a switchboard you will have switches, over current and other protective devices that you need bus bars, buses and then any other instruments like measuring instrument or power calculating instrument something will be there. So

all these things will be put together inside the panel and it will be closed. These devices will be mounted on the face of the panel or at the back of the panel or it can be on both sides of the panel. Therefore, the switchboard's main function is to allow the division of current supply into smaller currents. Therefore, whatever current that is coming inside the link it will be divided by the switchboard and sent to various areas of the building. Therefore, when you see inside the switchboard you can see one or more bus bars. The bus bars we saw in detail in the previous lecture. These bus bars are strips of copper or aluminum and the switchgear is connected to it. This will be carrying large currents through the switchboard and then insulators support it. Switchboard is mainly provided so that the operator whoever is using it is protected from electrocution. Electrocution is nothing but electric shock. Therefore, that is done by providing safety switches and fuses. Therefore, this is also a control for the supply of electricity. So wherever the supply is being given it will be controlled from one place. Moreover, when there is going to be a generator in the premises, like generator of electricity is also going to be provided, it will be passed through the switchboard where you can control the main electricity and the generated electricity can be controlled from here. The main thing that has to be taken care of is the amount of power going into a switchboard should be equal to the power coming outside. You cannot leave anything in between. 6.17

Now these switchboards when you take the types, the modern industrial switchboard which will be better enclosed \. The entire thing will be closed and dead front construction we call it. No energized power will be there. It will be accessible. The covers or panels will be provided. You can open and close it. Now we have large switchboards. It will be freestanding floor mounted enclosures. In these switch boards there will be a provision for incoming connections and outgoing. Therefore, it will be opened at the top and the bottom. Then you have something called panel boards, also called as distribution boards or electric panel. This is another component in the distribution system. It divides the electrical power. Whatever the switchboard does, it does it in smaller scale. So from the switchboard the current is

distributed, it comes to a panel board. This panel board again in turn it distributes the power into subsidiary circuits, like for lighting circuit, or for heavy power or motor loads, it will be distributed. Everything will be in one enclosure, meaning it will be covered. As per NEC, it is a single panel or group of panels. If it is a single panel it will be including buses and automatic over current devices. This is what I spoke about circuit breakers. And it can be with or without switches. Certain panel boards are providing switches and mostly you will not have any switches in a residential premise. It will be designed so it will be fixed or placed inside a cabinet or it will be put in a box and this box will be placed against a wall, partition or any other support. It will not be free standing. It will be accessed only from the front.

When you take panel boards, you can have two categories. The lighting and appliances will be one panel board and power will be on another panel board. Power in the sense we say 5 volts and 15 volts, 5 amps and 15 amps. Therefore, the heavier loads will be separated and kept in one panel board and the lighter loads like your lighting and appliances will be on another board.

Lighting Conductor:

Now coming to lightning conductor: - We saw about power handling equipment's. Therefore, whatever power is coming inside, we are distributing it very uniformly and an orderly manner inside the building. Now lightning is an electrical discharge that is coming from nature onto the building. So for that we need to have something called lightning conductor. These conductors are normally fitted on top of the building. Usually we take up the highest point of the building. And it is a safety device to protect them from the destructive effects caused by the lightning. If you see this image, when you take this as the building, this will be your lightning conductor and this is the cloud that is going to discharge the lightning onto the building. So what actually happens when there is a lightning? You will see a few metal spikes here, on top of the lightning conductor. That will be again connected by a thick copper strip and that will be buried deep inside the earth.

That is what is represented here. So you have spikes here, a conductor and then buried inside the earth.

Now what happens during a storm or if there is going to be very heavy rain? This is a thundercloud. The thundercloud is full of negative energy. So generally, clouds are made up of positive and negative energy. So when a cloud with too much of negative energy comes on to top of a building. What happens is, it tries to discharge that negative charge. So what we do is we provide this lightning conductor that induces positive charge. So this positive and negative charge will react and there will be a flow of electricity. Current will flow, the electrons will flow through this rod and electricity will be discharge though the ground. Now when you take up these conductors, we cannot use all materials for that. We have certain limitations on that. We can use either copper or aluminum. Why we use copper or aluminum is, mostly in electrical wires and appliances because they are very good conductors of electricity and they have a very long life. If you are using galvanized steel of the same cross section, it can be used instead of copper. Galvanized steel may be generally preferred for short life span buildings if there is going to be any temporary structure like an exhibition venue or something, you can use galvanized steel. You can also use non-metallic materials. You must consider the possible degradation that is going to happen due to ultra violet light, frost whatever be the conditions of the atmosphere. This has to be kept in mind while selecting a non-metallic material, and definitely non-metallic materials are very easy to install and electro-galvanic corrosion is not going to happen. But there will be a need to replace them more frequently. The life of your material is not as equivalent to your copper or aluminum.

When you install a lightning conductor what are the things you should consider? You should have at least two grounding points. Your earthing points must be at least two and make sure it is diagonally opposite, as far away from each other as possible. This lightning rod is connected here and the distance around the building at ground level between these two must be a minimum of 250 feet. And the rods that you are

placing, you will need more than one rod depending on the size of the building. So when you place that it must not be more than 30 feet and not less than 2 feet. Therefore, what we do is typically we keep a one foot for every 20 feet. So 20 feet is the maximum and 2 feet is the minimum spacing. It is a sloping roof this is a ridge. Then the cable that is taken from the lightning rod to the ground should be fastened to the building for every 3 feet it should be fixed. Connect vents and antennas with clamp or lug should be used to connect any vents if anything is coming within 6 feet of the lightning cable. If there is going to be another cable, vent, or something that is there within 6 feet it has to be clamped. That is closed completely. So when you take this cable down the building to have a very good appearance, neat job if you want to do it is taken around the spouts or moulding whatever is there. It will be not be just like that falling down from the top it will be taken along the corners of the building.

Now this earthing systems again Indian electricity rules they have certain system in place, which we have to follow in earthing system. So generally, we have TN system, TT system and IT system. Before going into detail, we will look into those what the letters represent. So the classification is based on the letters. The first letter will be on the type of earthing. Therefore, if you say the first letter is going to be T which means at least one point of the supply is directly earthed. And if you say I is going to be the first letter, it is not directly earthed but through a current limiting impedance will be used to do the earthing. Now when you come to the second letter, if it is going to be T all the conductive metalwork is the reason we are doing the earthing. So all the exposed conductive will be directly earthed if the second letter is going to be T and if the second letter is going to be N, the exposed conductive metal will be provided by the supply company, it will not be directly earthed. Now coming to the third and fourth letters if you have on the system based S or N. this will talk about the earth conductor arrangement. So the earth and neutral conductors are separate if it is going to be S. and combined if it is going to be N. so these are the basic abbreviations. So from that if we take TN system what happens is, because of T one or more points will be directly earthed and the

exposed conductive parts are connected by protective conductors that is what N stands for.

Now when you take TT System one or more points are directly goes to the earth and connected to local earth electrodes or independent source will be used. So depending on the requirement of the building we have to decide what type of system we are going to go. Now coming to IT system this will be unearth or earth the source will be unearth or earth by using high impedance because I is coming first then T is electrically dependent, the exposed parts are electrically dependent and earth .

Electronic and Communication Systems:

Coming to the electronic and communication systems. Generally communication is we are trying to send a message to the other people it is the act of transmission of information. So whatever elements are involved in this act like in the transmission of the information it is called the system and this is communicating so it called a communicating system. If you see this picture there is information source form here only your message is sent it is taken by the transmitted the transmitter is transmitting the signal through a channel and it is received by the receiver. So this is the main communication system we looking into. And this channel there might be noise present in channel depending on the channel that we use and the receiver will give the user whatever information that has been sent. Therefore, that is what a communication systems is is.

So when you take up communication systems you will have three things transmitter, medium and a receiver, so it is diagrammatically put here. So person is transmitting a message it is received by the medium here and medium is again is giving it to the receiver again.

So this information whatever we are going to convey if it is going to be in a electrical form ok that electrical form is what we call it as signals and it these signals you can send it only through a electrical or fiber-optic cable or free space also you can send these signals. Therefore,

this type of communication or the process is called electronic communication. Electronic signals are these signal that we are sending can be analog or digital or it can be vice or versa it can be changed into any form.

Now when we take up this communication we have to look into communication spaces so we are going to send information and going to receive information. So you need a particular space allotted exclusively for that so that you can send or receive this information, that area is what we call as communication space. In telecommunication, we call it as telecommunication space. This space it will have all the equipments, you know to send information and receive information it will have all the equipment and the cables all will come and terminate here.

Now this communication will be the central point room if take a floor. Generally, we prefer this communication place or the room to be in the basement, but is not necessary but it can be in the lower most floor we generally prefer.

Now we say according to the standard every floor should at least one telecommunication room which we call as TR if you can see this picture you can see two TRs for each floor depending on the size of the floor area. Now this TR need not be an exclusive room if it's going to be on many floors can be as a closet also closet means it will be a smaller room you know don't sit and work you just keep the equipment's there. Then you have this equipment's room, which will be the central part where all the TRs will be connected. This TR it should contain adequate HVAC, HVAC is it should have Air conditioner or sufficient ventilation and everything. And This HVAC we are providing, it should be preferably from a stand-alone systems. stand-alone systems means it should not be connected to the buildings existing HVAC it should have something separate and it should be continuously running.

And these you know something called communication pathways these are nothing but cable trays or conduits that take the wiring. These are the pathways that will transport the cables. The cable is going in this

path, from that only we got the name. Now we have horizontal pathways. Horizontal pathways are they carry the cables from the TR the telecommunication room to the place of work. so that is why we are having one in each floor. So from the room wires or cables be taken to the place of work that we want to have the communication system. Then this will be generally redistributed, if you have taken an IT office or something you will have zones where people will be working. Therefore, they will be divided into zones and each zone you will be providing the pathways taken to each zone. So if it is going to be a framed building with a column beamed structure between four column we will make it as a zone generally. Therefore, that will be the area from 30 to 80 Square meter will be covered. Now various TRs that is there in each floor it will be connected to the equipment room I told you. Therefore, the pathway that connects TR to the equipment room we call it as backbone pathway. So these backbone pathways they are generally you know if we prefer to stack the TRs vertically if we see this previous picture you can see the TRs are move one above the above stackes vertically. That when you take backbone pathways it easier to install. And when the floor has more than one TR, those TRs will be connected by the backbone pathways.

Now coming to voice and data, you have two types of electronics communication one is voice and the other is data. You have come across these terms. Now when the type of communication is done though telephone where you can directly hear the voice, that is voice communication. The data or information or whatever you have in the computer system it can be shared or sent to any other system geographically in any area or part of the world now-a -days. So this movement of information or data movement is called data communication. So you are communicating will not be seen or heard. So examples of your data communication will be your emails, chats, whats app chats, instagram, all these things come under the data communication.

Now what happens in a voice or dat communication, the electrical signals or whatever message is being sent through electrical signals is

carried along a conductor, optical signals along an optical fibre and electromagnetic areas. So based on the way you are communicating you can actually transmit the data. You can actually take it into three categories-Simplex, Half-duplex, and full duplex.

Simplex is the communication take place only in one direction. That means you can only send the communication in one direction. You cannot receive the communication or you can receive the communication and cannot send. Either one can only happen. That is simplex.

Half Duplex is you can send information in both directions, but only one direction can be used at one time. Like I send the information as to go and reach there, it should be received only then I can receive information. They can send information and I can receive it back. So it is like one way it can work at a time.

But when you say Full-Duplex, communication can happen both directions at the same time. This is what they are trying to show in this picture. There are two points A-B. Simplex is just one-way see one arrow head. Half-duplex it is two arrow heads, but you have separate arrows here. Full duplex is only one system is connected both the way.

Electronic Security System:

Now when you take any electronic system, we have to be concerned about security operations as well. Because we know, getting into an electronic system is easier. So when you take up electronic security system you have various systems, various things with the electronic systems one is Surveillance, other is Access control, alarming or intrusion control and then an areas where you use backup, instead of main power you use backup power there again you need to have security system. This electronic security system this is extensively we can categorize as alarms, access controls and closed-circuit televisions CCTVs, you would have heard about that. These things are widely used when you talk about electronic security. Where we usually use these things are corporate, work places, commercial places, shopping

centers, public places like railway station, and those places we find these security systems. Other uses of these security systems are fire recognition and avoidance system and then attendance record system. So these are the various electronic security systems in picture now.so based on the functioning we can again classify as CCTV Surveillance security system, fire detection or alarming system and access control or attendance system.

CCTV surveillances to watch over a facility. If you want your facility to be secured or if you think, some suspicious activity is going on there we generally install a CCTV network and watch over the place. Therefore, it generally has a camera or CCTV cameras. CCTV is nothing but Closed circuit television. These cameras serves as the eyes for the surveillance and this camera will transfer the images that they capture to a remote access place. Wherever you have a CCTV it does not mean that you should have he control there itself. It only acts as the eyes, it will be taken to a remote place, there data will be recorded, and it will be saved which can be retrieved in future whenever you want to look at it.

Then you have a Fire detection and alarming system. This alarming system, this will be like on the direction of the interruption or anything suspicious happened in a protected area or facility now alarm will starts to work here.the main function When you take up a fire detection is to rapidly extinguish and advancing fire and alarm the tenants for evacuation. So these two things will be done by a fire detection system but we generally have a detector will be via sensor and it will be followed by an alarm and it will be connected by an alternating circuit.

Another alarming system is no very highly secured area, when intruder is trying to come inside the same sensor will be used when they are crossing some path or something the alarm will be triggered and then you will have an alarm going off.

Then attendance and access control system:- When coming to attendance and access control system this provides a secured access

to a facility and or any other system it will control the access, people who are going to enter or leaving or when coming all those thing will be controlled by this system we call it as access control system. This will also act as an attendance providing system, which plays a dual role. So if you see her generally works on like this. So what happens is this finger printing, the finger print will be sensed here and it is converted it into signals and it is recorded, under this finger print the numbers will be given and it is recorded. So this will form as an attendance for them at places of work or you can use RF cards. RF cards are as if your ID cards will have RF ID tags will be there. That will be sensor and the sensor will record the data. Access control and attendance system this can be used.

Electrical Installation:

Now coming to electrical installation: - So we saw so many equipment's and so many things here and where it should be located, and how safe it has to be located. So major concern when you see here is , when you take an electrical distribution system, you'll have the main switch board ,like the thing is coming into a transformer and given to the premises. Therefore, inside the premises it comes to a switchboard, from the switchboard it is connected a distribution panel and from the distribution panel the circuit goes for all the wiring, one goes to the lighting, one goes to the appliances and from there it will be taken to the individual appliances. Then for motors going to be taken to the separately directly to the main switch board, because for the large motor you need huge voltage. Now the location should be such that this main board could be easily accessible, because this is the place where you are going to control quickly and it should be install in rooms or cupboards where it can be covered and the places should be very dry, be ventilated and adequate illumination is necessary for a main switchboard. When it comes to distribution boards, again, it should have protective devices like circuit breakers and there should be plenty of wiring space so that extra wires can be stored there for maintenance. So it should be as near as possible to the central load and it should be fixed to the wall or stanchion, and

protective devices should be minimum 1.8m from the floor level. Should be provided with the list of circuit diagrams distribution things that is done.

So coming to the summary of this lecture, we saw what the power handling equipment's are, what is the purpose of each equipment, and the various components in that and we went through lightning conductors, what is the purpose, materials used and what is the installation process of it. Then we went through electronic and communication systems, the different types of communication systems and we came across the electronic security systems and its various types. Finally, we saw the location and requirement when it comes to the main board and distribution board in an electrical installation system in a building.