Introduction to Smart Grid

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Lecture – 15
Digital Relays for Smart Grid Protection

Good morning to all of you. In this lecture we will discuss about the basics of the predictions part for the smart grid system. I will discuss about that the point that why we need protection and what are the components of the protection system, and what will do in the further classes. As all of you know that the power system is becoming more and more complex due to the integration of fax devices, renewable and also we have the relation markets.

So, due to this the system is more complex, and the protection system is also becoming more and more challenging day by day. But however, with the availability of a good competition facilities advance signal processing techniques. And of course, we have very much dedicated communication and computer infrastructure. So, it is quite possible to have very improved and advanced protection schemes for the smart grid system.

Now, the point is if you could see that earlier our network I mean distribution side mostly was passive in nature. But due to the integration of renewable like solar base technique or solar base renewable system or wind system or small hydro or we have fuel cells batteries. The network is not becoming more and more active in structure active in nature.

So, as a result the whatever technique protection schemes we have maintained for the earlier system those techniques need a very wide range of basically recalculation or rearrangement or more innovative structures are innovations are necessary for the protection part and that smart grid system. So, keeping in this particular mind so, in this particular curriculum or course. We have kept also the protection schemes for the smart grid environment. First we will discuss about the basics of the protection system mostly the digital relays will concentrate. And after onwards will discuss about the very first term that is islanding relays.

How this islanding relays basically help to island the system or micro grid system, that also will discuss very widely and essentially and then we will go for coordination of directional over current relays; where we will see that how this over current and directional relays are the essential components for the smart grid environment, where the as per as the protection is concerned.

So, coming to this structure it is a very known structure known layout for all of us, but you know the every corner of this particular power network we need this protection scheme. Without protection the system is basically not possible to operate perfectly at 50 hertz signal. You know, that the 5 percent of the money basically we dedicate for the protection infrastructure of the system of the power network.

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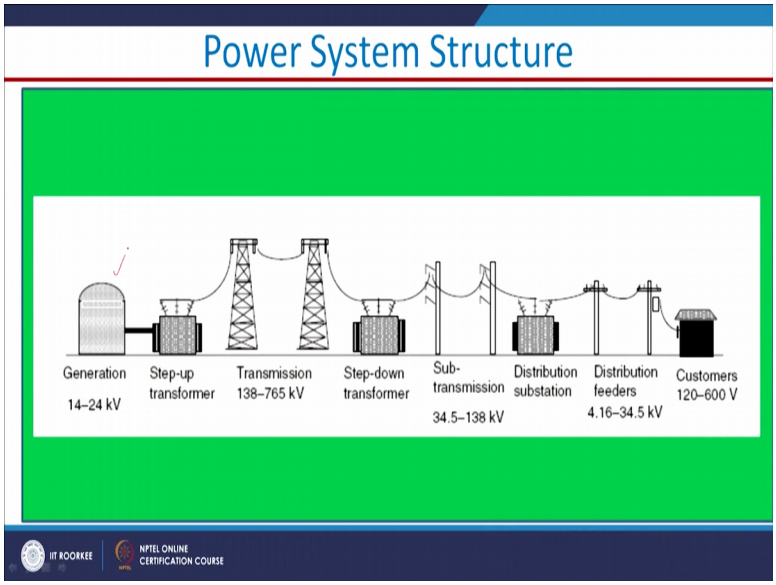

You can start from this generation, that is here the generation, we have this type of transformer, and we have the transmission carried over we have the transmission infrastructure that is basically 138 to 765 kV range and also India is aiming for 1200 kV infrastructure of the transmission system. Next we have step down transformer, and yes, we have sub transmission system distribution system, and finally the consumers. If you could see the wide range of this power network at every corner, we have to basically protect every element by element we have to protect it.

So, that our system will operate in a reliable mode in a very accurate mode, and we can supply the quality things quality supply to the customers. That is actually out here our

aim and that is also aim of this smart grid environment. So, where we should not get any interrupt interruptible power, the power should not be interrupted to the customers, and the quality of the supply that is the frequency and voltage should be maintained at the particular label. And so, without disturbing anything the customers should be satisfied. And 24 into 7 power supply should be maintained with in a efficient manner, in the first manner and in a smart manner.

So, that is what this smart grid protection schemes aim. And if you could see that in every cricket match we basically go for this helmet, we go for pads so, these are basically for the protection of the body. So, similarly for protection of all the elements of the smart grid system, we need some protection elements. See this already we have discuss that our system was earlier, If you could see this central utility system, it was just in a one go or one flow direction best power flow system.

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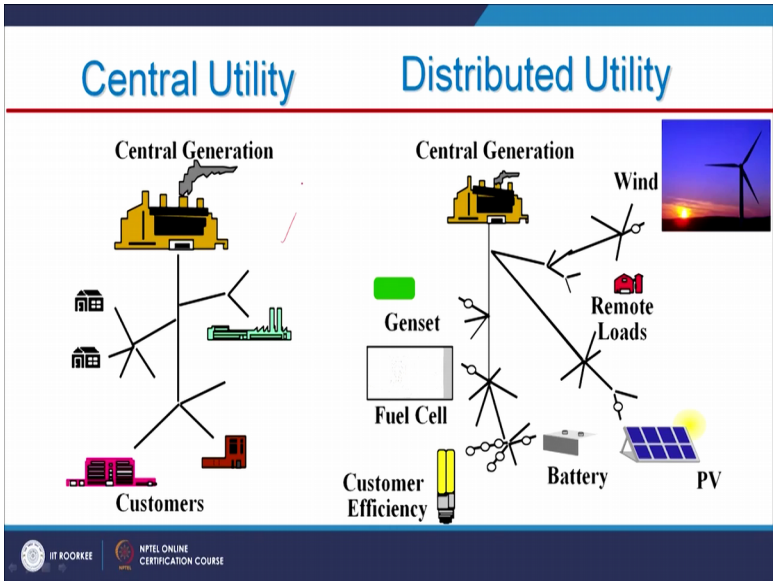

This was actually the central generation, and we have further the customers, the power flow was unidirectional, but now the scenario has been changed, that here if you could see you have central generation, we have like fuel cell, we have PV, and also we have battery, and also we have wind. So, so many renewable energy sources are now integrating, they are penetrated to the network and this power flow is now becoming multidirectional. It is not anymore unidirectional, that is the first point we have to be very careful so, while designing this protection schemes of the system or network.

That is our first motivation, that if it is the key point basically, this is a main driving force that it compels us that we have to develop some new protection schemes are algorithms, or techniques, otherwise the system cannot operate at the 50 hertz, this straight 50 hertz signal. We have to maintain certain accurate protection schemes.

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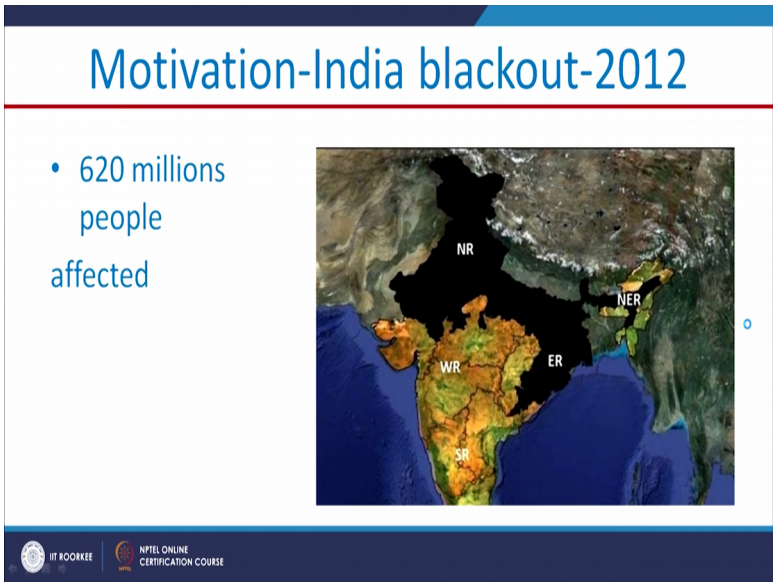

And next if you could remember our last blackout in India, in 2012 July 31st that this whole northern grid eastern grid and northeast grid, this 3 grids are just disconnected from the rest of the 2 grids, that is what it motivates towards that this particular blackout this is a very big disturbance, and very large disturbance. Due to this disturbance 620 millions people effected this figure is not a small figure. And you know, it had happened due to the protection failure only, one of the digital relays that is known as distance relay the it was due to the load enforcement problem the (Refer Time: 07:25) kV line was tripped, and after that other lines are overloaded.

And finally, the disturbance propagated and this particular system event is known as cascading failure of the transmission lines or lights. So, due to that the whole grid, northern grid then the northeast grid and eastern grid also to some extent all are disconnected from the rest of the 2 grids. Due to this we have lot of problems we face in the last 2012, and many more blackout also had happened throughout the globe India also.

So, we are trying to just check this kind of major disturbances as quick as possible so that we can save our economic, and our also we can save our society, and also our citizen. That is what our main motivation, that we keep all the techniques very strong and efficient. So, of course, we can always check this kind of major disturbances. Coming to the topic what is that our relay as I said the digital relay or electromechanical relay or static relay we can say so, this relays are the heart of the protection infrastructure.

So, without relays there is no question of protecting any equipment. That is what yes, of course, we have many other protection devices like fuse we have recloses, but; however, relay is the major components one of the major components as per as the protection infrastructure is concerned.

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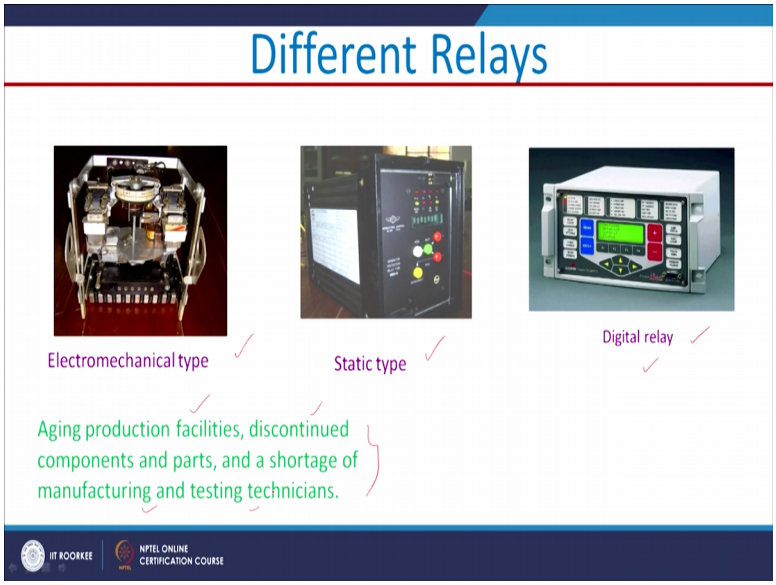

Now, if you could see here we have electromechanical relay, we have static relays, we have digital relay. Now the question is why I have kept this 3 figures. Because we have one evolution, we started with electromechanical relay again we use this static type relay, also now we are using this digital relay. The question is why this evolution because we are moving towards smart grid. We are moving towards say computerized, digitalized network or society or power network, where we have to basically make the components to speak to each other.

To share the data information with each other in that platform this electro mechanical relays are not anymore capable of doing that. And where this digital relays possible with

help of this digital relay it is quite possible that 2 relays, or 10 number of relays, or 100 number of relays can speech to each other. They can share the data information with each other, or those relays can send the voltage current frequency power, whatever the information we need at the central label central control centre of the smart grid system, that is also quite possible.

If you could see that I have just pointed out few points, this aging production facilities discontinued components and parts, and a shortage of manufacturing and testing technicians. So, these are the demerits of this electromechanical based relays that is why we are moving towards this digital relay. Another advantages I mean this ppt emphasizes these are the advantages of the digital relay and these are the disadvantages. Also this points also motivate us that why we are just choosing this digital relay, why not electro mechanical relay? Why not static relay?

The first point is the cost of the relay, yes, I will just address here the cost of the digital relay is more than the electromechanical relay because we are trying to minimize or customize properly the different components of this particular digital relay, and we are also trying to reduce this cost also. As this electronic gadgets are mostly used inside the digital relay, like, analogue to digital convertor, the processor or digital analogue convertors. So, different types of electronic gadgets are involved inside this particular relay digital platform based relays.

So, we are trying to reduce this cost also slowly. The second one is this self-checking, this relay has the capability of self-checking, if any fault occurs inside the circuit of this digital relay, it is possible quite possible to check itself, that yes, at this point there is some fault, this relay can take care. It is reliable and accurate, because all the flow of the power or the signals basically controlled is in the central controller, and also the flow data flow basically are very quiet reliable inside the structure of the digital relay.

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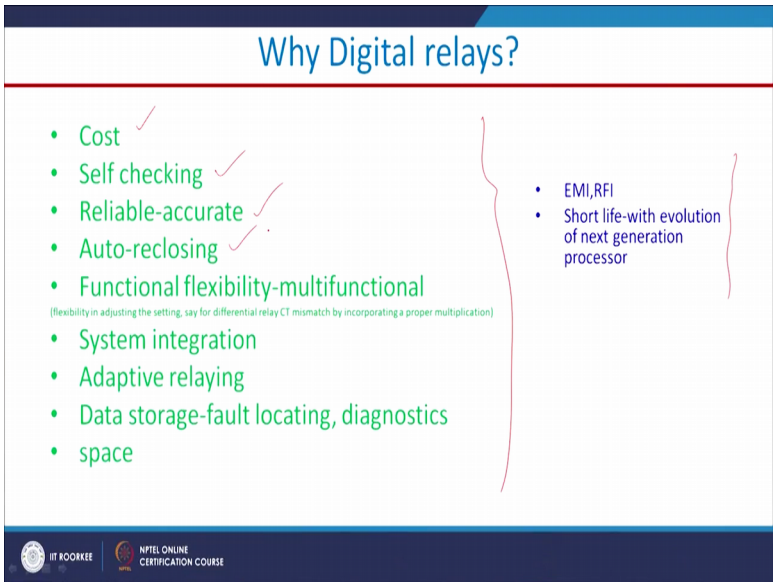

It has also the function of auto reclosing, and this one is very important functional flexibility, multifunctional flexibility. Here I just want to address that, suppose if I will purchase one digital relay that this particular really work for me as an over current relay, directional relay, distance relay, differential relay earth fault relays. So, we have different types of relays in power systems, those relays are basically used to protect the different components like transmission or distribution lines, transformers or some different type of components.

So, in that case what we do? Basically a single relay if we it will just act as different types of functions. So, it is a very like a gift for us, like we can we will be happy with less cost we can have multifunction's. So, that particular multifunctional facility is available with the digital relay. We have also system integration, system integration is quite possible. As we have discussed, from the digital relays, or we can always share the data from one substation to other substation, one area to other area. That is what this system integration. And adaptive relaying means another feature of this digital relay where with the system parameter change, or with the system network configuration change this relay will just adapt accordingly to change the settings.

So, that we can protect for any disturbance so that we can protect the network for any disturbance which is going to be inserted in the circuit. And also it has this data storage, that is the fault locating diagnostic, and these are the features other features of this digital

relay; where it has the capability of detecting the fault where the disturbance has occurred or how to take proper remedies against this particular, it will also give the pinpointed position of the disturbance so that we can further maintain for go for the maintenance purpose.

So, these are the different features of this particular digital relay. And the space is also matter where is basically we can reduce by proper design of this electronic parts of which are involved in the digital relay, the digital relay space can be also more compact.

Nowadays, we are moving towards the development of different advanced technologies. So, with that further also the space of this digital relay can be produced. And this coming to the disadvantages of this digital relay, we have EMI and RFI effect. Electromagnetic interference radio frequency interference, those interfaces are basically present in digital relay. And short life with evolution of next generation or processor, you know, as already we have discussed in digital relay we use the electronic gadgets. So, if the process suppose processor one or 2 I am using.

So, some version of the processor if it coming with some involvement with technology development. So, we have to basically rely on the latest technology or latest based technology based processor we have to utilize in the digital relay. That is what this with evaluation of next generation processor we have to replace the technology with the recent or advance phase of the products, this means soft systems of a digital relay.

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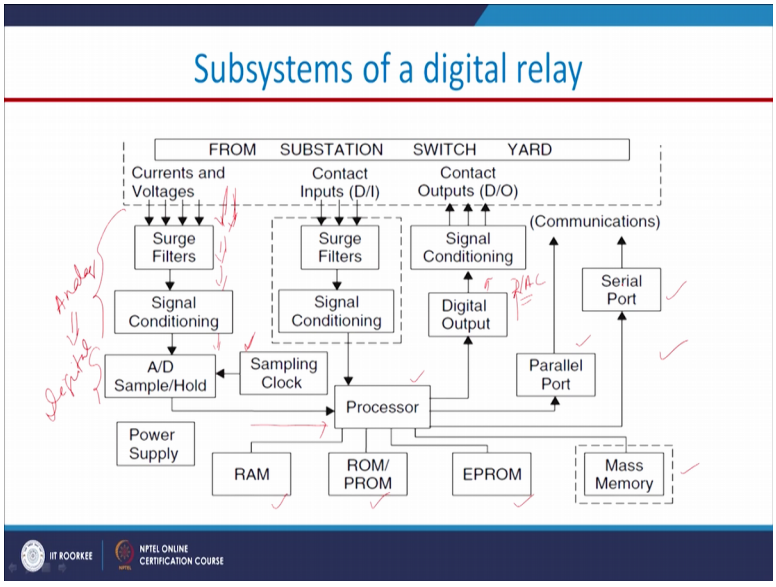

If you could see that we are just tapping, this voltage current signals from the substation or switch yard, this substation inside substation we have measurement CT's and PT's this PT's the provide the voltage signal and CT's provided the current signal. So, there we will just tap the voltage signal and the current signal. And this current voltage signal, signals will the fed to the surge filters. Surge filters means it will just remove any surge any high frequency component which is present within this voltage current signals.

So, surge filters will help in removing those high frequency components. Next we will go to the signal conditioning stage. The signal conditioning block helps in maintaining the signals at the desired frequency level. That is what the signal conditioning block dash.

Ah basically we have low frequency low pass filters, and where we will just allow the desired frequency that is 50 hertz signal and also we will remove the high frequency signals or undesired signal frequencies, I mean frequency components. That is what this signal conditioning block helps. After signal conditioning block, it will go to the ADC that is the analogue to digital converter. There basically we have one sampling clock is ready, to sample the data at particular sampling frequency, what sampling frequency will maintained so that the voltage current signals are going to be sampled at a particular time interval?.

So, 1 kilo hertz or 2 kilo hertz or 4 kilo hertz what sampling frequency, where going to maintain. This ADC will help up to this we have the signal analogue, and here the signal will be converted from analogue to digital platform. So, this conversion is possible during this ADC analogue to digital convertor. After this conversion of this analogue signal to digital, it will go to directly to the processor.

The processor is basically the central unit of this central block of this digital relay, where all the algorithms are executed. If it is basically an over current relay, the over current algorithm is going to be executed inside the process of this digital relay. If it is basically distance relay or a multifunctional relay so, all the algorithms are just returned inside burnt inside this processor so that what about the options modes will just opt.

So, accordingly the output is going to be coming to our system. After this processor we have also different parts like for this processor, we have RAM, we have ROM, PROM also EPROM and mass memory. After this the digital output will go to another signal conditioning stage, and from here we can take it out for our external use, you know this

digital relay provides the digital signals and also analogue signals. After this digital relay this digital signal we can always converter this D to A.

Digital to analogue convertor we have also, if we need this analogue signal from the analogue d to a a c converter we can take the analogue signal. And also we have like serial port parallel port to communicate one relay with other relay. If the 2 relays will speak to each other, they can share the data with each other during this facility, which is basically present inside the digital relay.

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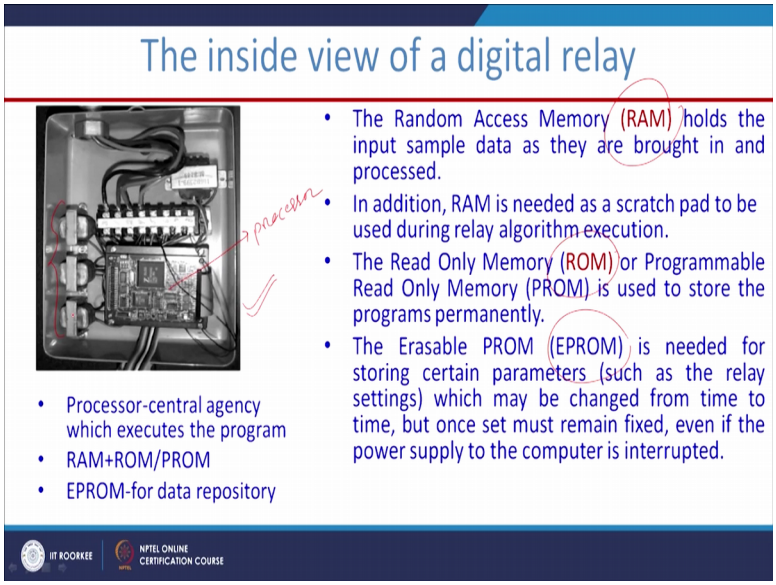

I will discuss here 3 points, the first one is the RAM, second one is ROM, and the third one is PROM or EPROM. What are the functions of these memories of the digital relay? This is the internal view of this digital relay where you could see here this is the processor, this is our processor card. And this 3 sections we have shown the CT's. Inside the digital relay also we have CT's. It will just scale down the current and it will convert to the voltage and it will supply to the ADC, and from ADC it will go to the processor. All the calculations and the based on the voltage signals only even if we are supplying the current to the digital relay, it will convert to the voltage signal, then it will be used inside the processor.

Now, coming to this RAM part, this RAM it is just basically random access memory; it holds the inputs sample data as they are brought in and processed. Basically it is a kind of scratch pad, here it I have written here. It will just catch the signals. It will just hold

the this particular digital signals, then it will allow to move further, it will allow to pass the signal to the processor. Again after certain time interval previous data will be lost. And new fresh data will reach to the RAM and again it will process to the processor.

So, basically it is a scratch pad which is basically used during the relay execution algorithm. So, when the algorithm is executed inside the relay. So, this particular section memory section of the digital relay will supply the data to the processor for execution of the algorithm. And you know it is random based it is not permanent memory. Now coming to this ROM it is basically the read only memory. This read only memory or programmable read only memory sometimes PROM will also call it. Used to store the programs permanently, you know, we are building this programs or algorithms inside the processor.

So, those algorithms programs are going to be stored permanently inside the digital relay, and that is basically possible that particular algorithm is possible using the ROM read only memory. The third one is EPROM that is the erasable ROM, right it is used for storing certain parameters like the relay settings. We will discuss about this what is a relay setting in over current relay, we said the current value.

So, what is the initial current magnitude so that if any current exceeds that particular setting value, then the relays is going to be mall operator or it it will just it will just give some trip command. It is not mall operator, it is going to give some trip command, if it is exceed certain threshold value or setting value. That setting is basically present inside this EPROM that is what. So, these are some of the memory sections of this digital relay.

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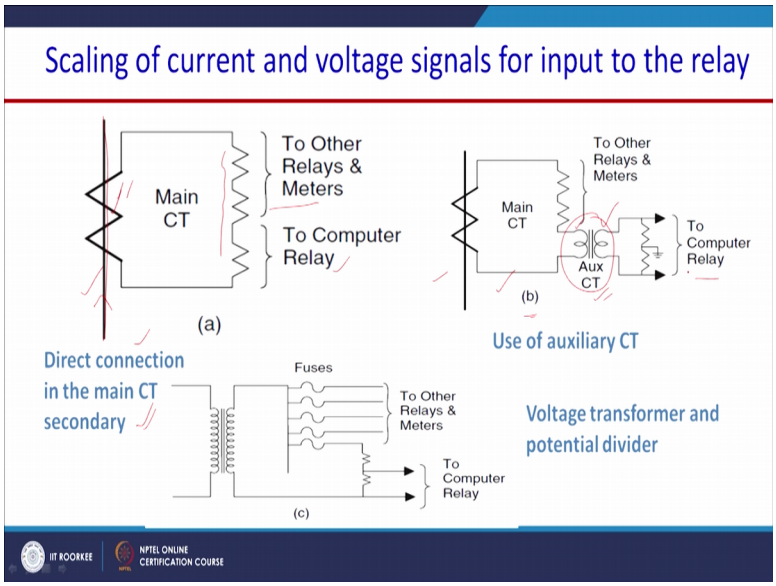

And also we have this we will discuss in this slide the CT different type of CT connections for the digital relay. This is suppose the main CT, this is the power line, where the current is flowing through this particular line power conductor. And this CT is the, you know in case of current transformer we have the primary as a power conductor. Where the power is moving I mean it is flowing from one direction to other direction, and this is our CT secondary, we are expecting we are scaling down the current to a lower level which is going to be feed to the digital relay right.

So, this is actually the main CT and these are the resistors part the secondary side of the CT. And from here we can tap the current values to the relays or we can also feed to other meters, these are the things. Or we can also said this current data to other computer based relays. This is this type of connection is known as the direct connection. Directly the relay is connected to the secondary side of the CT.

That is why the name is direct connection of the main CT secondary to the digital relay. Because we basically the relay takes current and voltage from the secondary side of the CT, or PT then the processor will execute the algorithm and it will just provide some trip signal. That is what the aim that is what the thing happens inside the digital relay.

Now, in the b section, the b figure if you could see here we have the main CT, after that we have auxiliary CT. Directly here the digital relay is not connected to the main CT. Rather the relay is connected to the auxiliary CT secondary. Here is the auxiliary CT, this

is the primary and this is the secondary. This secondary is connected to the computer relay sometimes it is digital relay also known as computer relay or numeric relay.

Because it is basically if you could see the, this digital relay operations mostly it is related to the computer, how the computer operate the same way the digital relay operates. The third one is a, we have this voltage transformer connection, this is our PT. We have primary section, this is the primary winding and this is our secondary winding. Through different fusses we can take it the secondary voltage we can take to other relays or meters and also we will supply to by scaling down the voltage further we can always supply to the digital relay.

This is basically the potential divider section, potential divider section we use, because the relay is basically it is a very sensitive device it is an electronic device. So, there we expect we should scale down the voltage and current to lower level so, that the ADC card and the processor card should not be affected.

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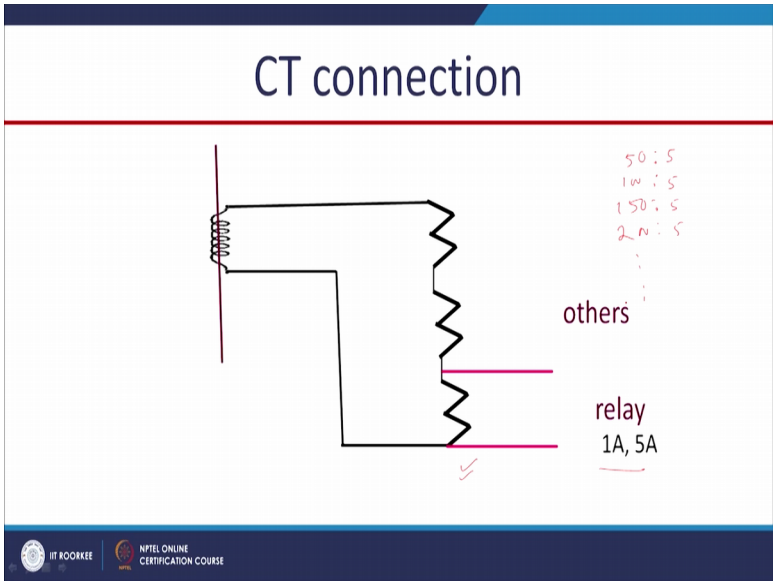

This is how this in Indian standard, we have the CT secondary current is within 1 ampere and 5 ampere, that is what the Indian practice. And if you could see that nowadays the manufacturers basically they manufacture the CT ratio in the range of like 50 is to 500 is to 5, or 150 is to 5 or 200 is to 5 and so on. So, by usingthese CT ratios we can always calculate I mean the current corresponding primary current inside the digital relay. Similarly, if a PT the secondary voltage, we have 110 volte phase to phase right.

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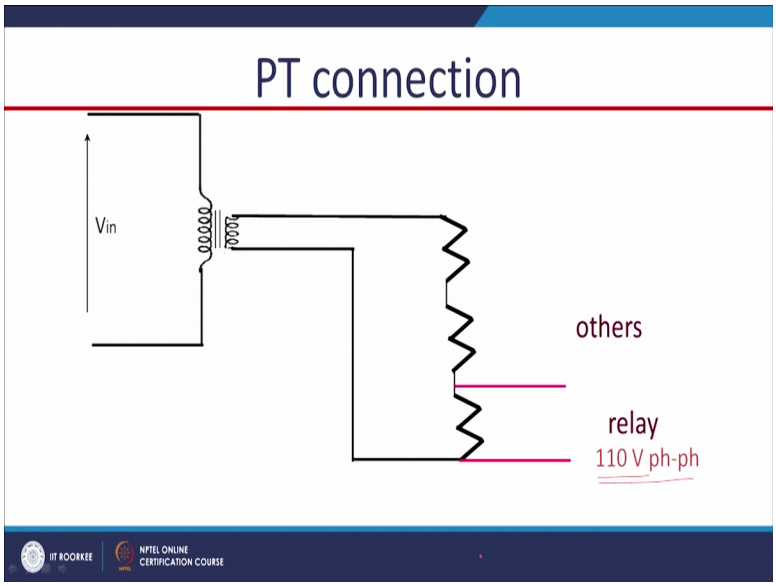

So, this is the input voltage, this is the primary of the this PT, and this is secondary side and here also we can divide the voltages using the voltage, divider or this is potential divider, and we can supply less amount of voltage. Yes of course, that will be again multiplied with the ratio inside the process of the digital relay to get the exact voltage information, right. So now, we will come to multiple signals sampling processes and this it is a organization.

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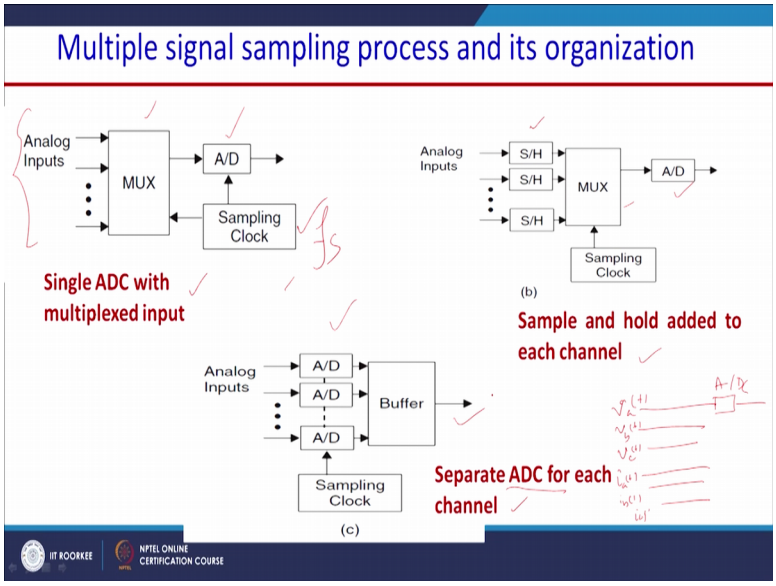

We have now, started with converting this analogue signal to digital platform. And you know MUX is basically one electronic component, which helps in converting this carrying out this many analogue signal to many digital signal many analogue signal or many to one also.

This MUX is a multiplexed input so, these are the analogue inputs, may be voltage signal may be current signals will supply to the input side of this MUX. And from MUX it will just go to the ADC. This ADC is basically the block where this analogue signal is going to be convert into digital signal. And of course, this sampling clock is necessary, as we have discussed earlier that the sampling clock block this particular block will provide this fs sampling frequency at what rate we are going to sample the voltage current signals. That is what the function of this sampling clock block.

And also this is one feature and further this is another architecture, where also we use sample and hold circuit before passing to this mux, the voltage current signals and after that to be just provide this different analogue digital converter, for converting this analogue signal to digital. And sometimes also we do in this manner also; this is a third one, separate ADC for each channel.

Let us I have 3 phase voltages this is V a V b, ok, this V c all are basically the analogue signals. And also we have current signals I a t and I b t and I c t. If we have multiple channels signals, in that case also we can use individual ADC individual ADC analogue to digital converter. That is what this particular section and using this offer we will supply to the processor further action. Now here we will come that the sampling process as you know in the digital relay platform the sampling process is very, very important.

This is how this signal processing techniques are nowadays are very strong, basically if you have to use this digital relay so, we have to make very advance signal processing technique should be evolved quickly.

So, that it will just process the signals, and it will estimate the phases or frequency for our use. If the relay is basically let us say based on the distance relay. So, we have to calculate the distance of the fault, at what location the fault has occurred the fault has incepted. So, if our signal processing technique is not that much of efficient, a signal processing is not strong, so, obviously, it will be delayed in calculating this phases or calculating the distance of the fault.

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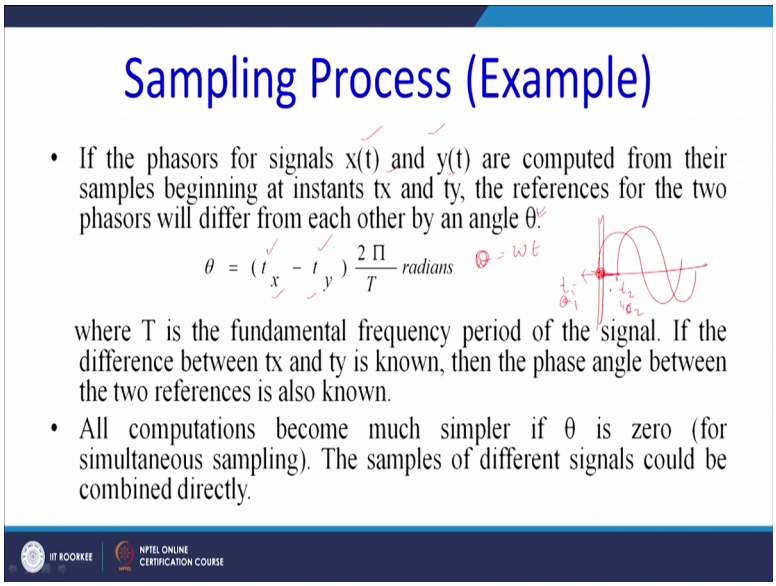

That is why this signal process signaling sampling process is one of the major part, parts of the signal processing technique, sampling process. If you just take one signal, at what sampling rate we are going to sample the signal that matters a lot. We will discuss about this particular point, that how the something process affects the performance of different relaying techniques or relaying algorithms. If I will maintain a 2 kilo hertz, what is going to happen if I will maintain my sampling frequency at 2 kilo hertz so, what is going to be result.

So, that is what the impact or effect of sampling process on digital relay platform, or digital relay processor or algorithm execution we can say. Let us say we have taken this x t and y t 2 signals and at certain time t x and t y, how to calculate this theta you know this theta is equal to omega t. So, if we have like 2 different I mean phasors of signal x t and y t for complete their samples at instant tx and ty, the references for the 2 phasors will differ from each other by an angle of theta.

So, time this t x, what does the phasor angle phase angle of this particular signal x, and a t you know for as a phase angle? So, difference between 2 we can always subtract and we can calculate this angle difference between 2 signals right. So, by this signal processing technique it is quite possible. We can always compare that from the reference point, let us say this is another signal, this is my reference signal.

So, what is the phase difference between these 2 signals? So, at this point what is a time and the corresponding angle, at this point of time so what is the corresponding angle theta 2? So, let us take the difference between these 2 we can always calculate the phase angle difference between the 2 signals whether it is leading to the signal or it is lagging to the signal.

So, of course, we have take some reference signal that is very, very important. Without reference it is not possible to say that whether the signal is leading or lagging, that is important. The reference point is very important. Now that is sort the sampling I mean we have taken this 50 hertz signal.

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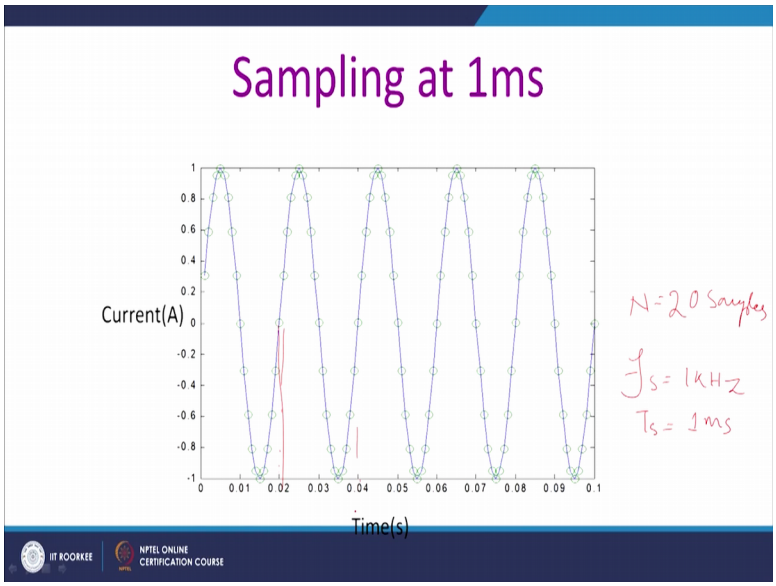

See this is here 0.02 one cycle ends here, one cycle starts from here one cycle ends here, and next 0.04 second cycle 0.06 third cycle 0.08 forth and so on. So, if will take let us say at one millisecond interval; that is basically fs is equal to 1 kilo hertz, and your sampling time interval is equal to 1 millisecond.

So, of course, we will get 20 samples per cycle 20 samples. That is what shown here, if will calculate within this 0.02, exactly 20 samples we are going to calculate. And within this 0.04 we are going to calculate 40 samples. So now, the sampling rate is very, very important, we should not exceed the over sampling or under. Sampling the sampling should be perfect as we have discussed during our PMU part of the lectures that already I have discussed what is anti-aliasing effect, sometimes what happens in digital relays or

in a power network, while sampling the signals the fundamental signals should come to the processor.

Because we are interested to calculate the fundamental frequency component of the phases like the phase angle or magnitude of the fundamental frequency signal. And sometimes intentionally also we calculate the phase angle and magnitude of some certain harmonic signals for our application purpose.

But anyway if you suppose sometimes what happens? The higher frequency signals behave it is like fundamental frequency signal or low frequency signal. So, that kind of effect is basically known as aliasing effect. In digital relay platform also we do that. We basically remove that aliasing effect using the anti-aliasing filters. That is that comes under the signal conditioning block. And apart from that also we have maintain this nyquist criterion, that during the sampling we have to maintain the sampling frequency in such a manner that the sampling frequency should be 2 times greater than the higher frequency component, which is present inside the signal.

So, those are the concept techniques are maintained while designing the digital relay. This is another sampling rate you know if you go for lower sampling rate or higher sampling rate so, corresponding number of samples per cycles basically cycle it will reduce the number of samples per cycle is going to be reduce are going to reduce. If we will take let us say 2 kilo hertz, then the number of samples will increase. If we will take 1 kilo hertz the number of samples per cycle is 20.

So, similarly if you will just keep on increasing or decreasing the sampling rate, the corresponding number of samples per cycle will also reduce increase or decrease. Now we will come to 3 major terms which are use for the digital relay platform will discuss, and the subsequent classes will discuss in detail the protection part of the smart grid environment, first we will start with the islanding detection of the smart grid environment. Then I will go for the directional over current relaying practice, which are basically used for the protection of the smart grid environment.

Now, I will come to this relay reliability term, you know, the reliability term itself defined as the redundancy, can be achieved by redundancy duplicating the relaying system.

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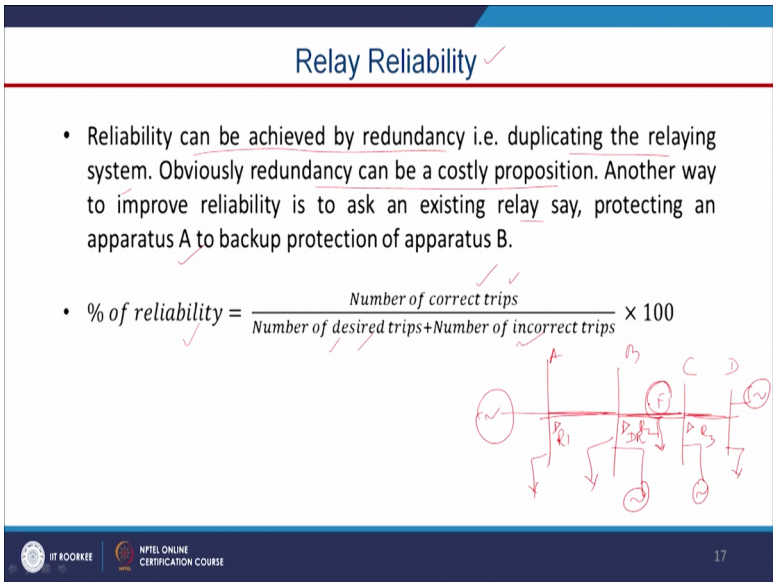

And this redundancy can be costly proposition another way to improve the reliable to ask an existing relay, say protecting an apparatus A to backup the protection of apparatus B. This figure can be also quantified like this the percentage of reliability is equal to the number of correct trips divided by number of desired trips plus number of in correct trips.

Suppose let us say we have one power network and we have different loads are enables are integrated in the system, and also we have loads at different busses. And in that case what will happen? And how this relay will trip? At what condition it should trip? At what condition it should not trip? That that is basically resided by this reliability property of the digital relay and this reliability is divide into 2 parts basically the dependability and security of the digital relay.

So, we will discuss about this next slide this reliability 2 types dependability and the security. Now coming to this part this equation if you could see what is this numerator thing. Number of correct trips, because we are designing certain device this particular digital relay, it should trip when it is desired, but it should not trip when it is not desired when it is not intended to do that. That is what the meaning of this particular reliability in (Refer Time: 37:59). If you suppose I have just mounted here one digital relay, this digital relay DR, if any fault occurs here in this section so, what will happen? So, this

line is now a faulty line. But however, if I will just denote A bus, B bus, C bus, D bus. This A bus, B bus, this line A B is basically healthy line.

Similarly, this line CT is also one health line. The relay should not the relays which are present at different buses; they should not respond for this particular fault, remember this is very, very important, you should understand that, what is the meaning of this dependability, what is the meaning of the security, what is the meaning of this reliability.

The relay should be so reliable as the name suggests reliability means, it should be so reliable, it will just trip for what for what purpose it is designed or it is intended. That is what this meaning of this number of correct trips divided by the number of desired trips plus the number of incorrect trips, right. So, the desired trips plus the number of incorrect trips total number of trips, what the relay will produce and that is what the denominator part.

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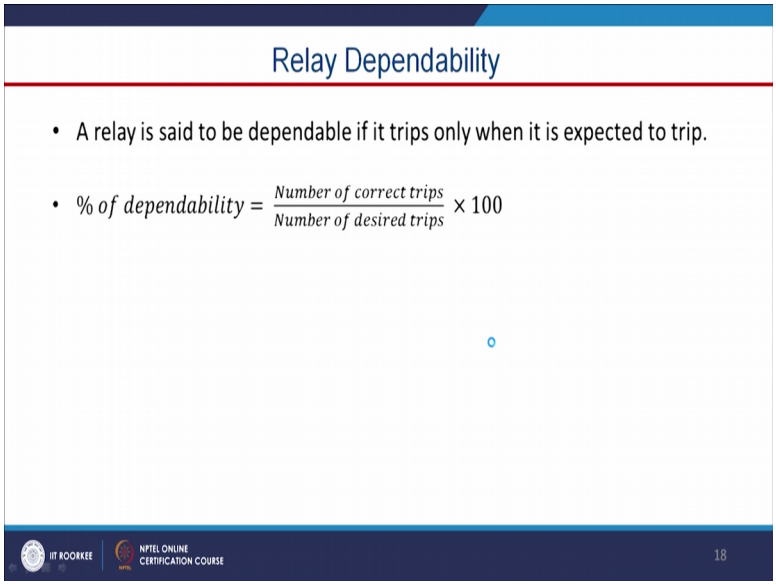

Now, if we will come to the dependability part. This relay is said to be dependable if it trips, when it is expected to trip, this is very important. See we have already discussed in this particular figure, that if some fault will just occur or the fault is going to be incepted in line section this BC. So, relay DR is responsible to clear to that particular fault; however, this let us say this is A R 1 this is R 2 this is R 3; however, at this point this R 1 and R 3 are not going to respond for this particular fault f which is incepted in line

section B C. That is what the meaning of this dependability function or dependability property of the digital relay.

Now, it is it should trip if this is expected to trip. If any fault is within this zone, we will discuss, what is the zone of the digital relays, if the fault is within the defined zone or area of this particular relay, then the relay is going to respond. That is what the dependability, and also we sometimes quantify this figure that is this word the dependability. How number of characters divided by number of desired trips?

So, that is what this dependability percentage. Now the third one is the relay security. The security is that property of the relay, where the relay is basically designed not to operate for any outside zone faults. Suppose let us say some fault is let us say as I discuss in this figure the fault is in section B C.

Now this relay R 1 R 3 so, it remain silent. This 3 this 2 relays out of this 3 relays 2 relays should not operate for the fault which is incepted in section BC. That is what the security of this property of this 2 relays. Only this relay R 2 is going to respond for the fault which is incepted in section B C. That is what this security terms and how to quantify this? The number of correct trips divided by the total number of trips. That is what this security is defined in figure.

So, in this particular class we have just started the protection aspect of the smart grid course. In this course that is our introduction to smart grid, we are just trying to have information or some concepts regarding the protection infrastructure. And here we have discussed the basic block diagram for the digital relay, and where we have descript how this analogue signal flows, and it comes to the processor and further is goes out for taking out giving some command to the cyclic breaker. Or also the stationary also will communicate to other relays which are present in inside this network of the smart grid environment. And also we have discussed the sampling rate, and how this particular sampling rate will discuss in the further classes.

And thank you.