Power System Protection
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Lecture 18
Introduction to Distance Relay

Welcome to NPTEL Power System Protection course. In this module on lecture 18 we will go with the distance relaying and on the lecture, we will have the introduction to distance relaying.

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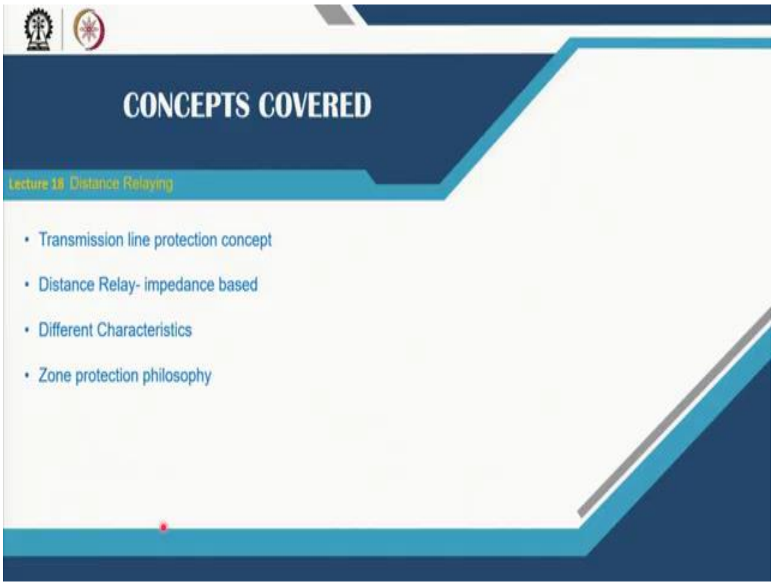

This lecture covers transmission and protection concept distance relay, how it is based on the impedance relay that we will see, different characteristics of the distance relay and how the zone protection philosophy is applied for transmission network, we will cover that part.

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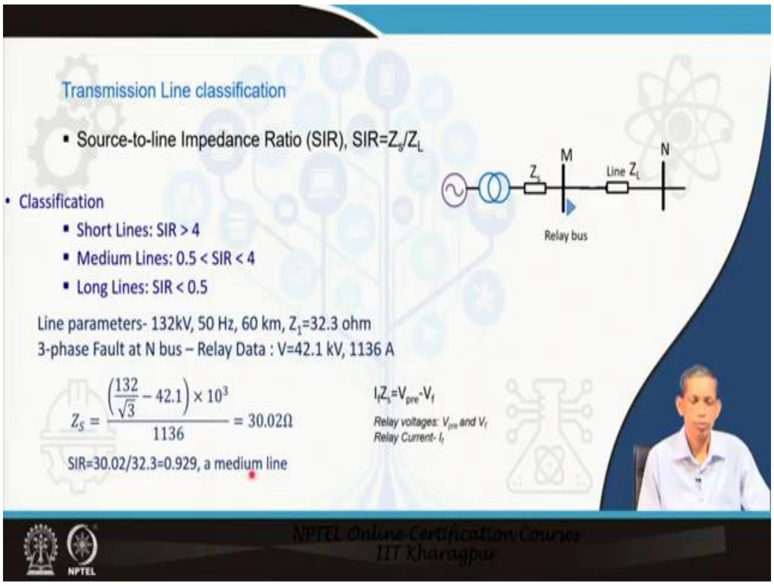

Now, before going to the details on distance relaying, we will classify different transmission lines in terms of protection. We have learned basics of power system, how transmission lines can be categorized, but in protections we have a different philosophy. Let us consider a system like this and we are concerned with the protection of the MN line section, behind this there is an equivalent source which is feeding to this line, maybe transformer or generator and combination of transmission line and so.

So this is an equivalent system which provides us an impedance of Z_S and the concerned transmission line is having an impedance of Z_L. Now, we define a term called source to line impedance ratio SIR. So it is a ratio impedance, unitless. That equals to the Z_S by Z_L where the Z_S is the source behind this, we can call it Thevenin's equivalent and the Z_L corresponds to the line impedance.

In that case, in the protection perspective, we classify the transmission line into short line, medium line and long line when the SIR becomes higher than 4, that is categorized as short line that implies that the Z_S value is more than 4 times Z_L, very unusual. Medium lines 0.5 to 4 SIR lies between this and long line the SIR happens to be less than half. So, that implies that in this case, when it happens to be a long line, this impedance becomes much more than the source side impedance, but in a short line, few kilometers, the line impedance may be lower and lower, maybe much lower also than the source impedance, as in the equivalent system we see in the single line diagram.

For example, let us the line parameters for a 132 kV, 50 hertz system is like this 60 kilometre long and it has a positive sequence impedance of 32.3 ohms is given, we create a 3 phase fault at bus N. And the relay data provides that the voltage at this point phase voltage is 42.1 kV and the associated current becomes 1136 ampere. In that case, how we will find the SIR for the system. So this is what we are trying to figure out what is the corresponding SIR of the line and then in which category the line belongs to out of these 3.

This is important from protection perspective. In the later lectures we will see this relevance of this on which protection schemes can be good at in which category of the lines. We see here one thing that before the fault, let us say the line was not loaded. So, we expect that the corresponding bus voltage will be usual voltage and there is 132 kV line to line. So, phase voltage will be 132/√3.

Now in case of a fault the voltage 3 phase fault here, balanced fault, so only positive sequence will be on. So, in that case this V_f at this point will be nothing but the corresponding line impedance drop here to the line. So, therefore, $I_f Z_s = V_{pre} - V_f$. So, that gives you a scope to find out the Z_S value from this perspective. The other way we say that before the fault, this bus was having a voltage of 132 kV line to line now, following you can see that the corresponding bus voltage here happens to be 42.1 kV phase voltage that is what recorded by the relay.

So, therefore, we say that the Z_S becomes equals to $\frac{\left(\frac{132}{\sqrt{3}}-42.1\right)\times 10^3}{1136}$ and that gives us 30.02 ohm. So, that is what the Z_S as seen by the corresponding relay the source side impedance as observed by the relay will be 30.02. But the impedance of the line is even is 32.3. So, this becomes 32.3, the value of SIR, ZS by ZL becomes 0.929. And if you see this category, this belongs to a medium line category. And that is what we classify these the different lines from protection prescriptive.

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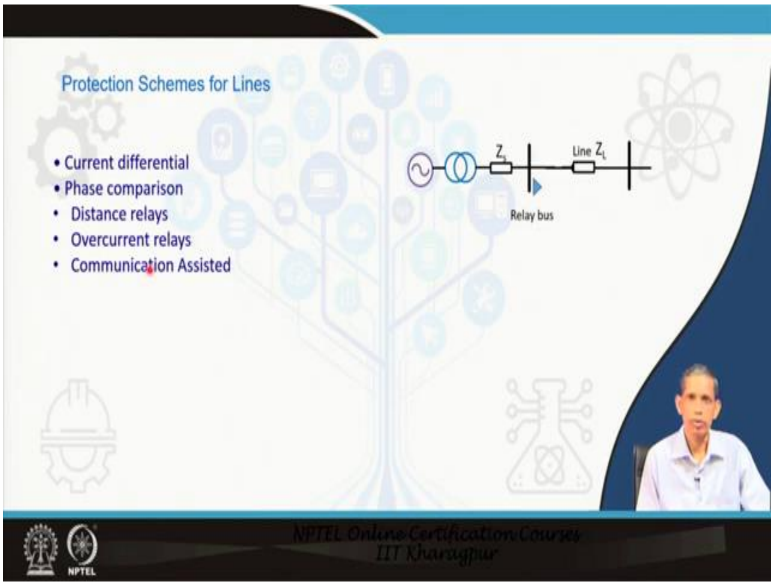

Protection schemes for transmission lines involves current differential. So, we can have a CT here, set of CTs, and then have a difference of current, we will see more on that later on. Phase comparison signal this side and signal this side, phase information of current and so, can be compared using the communication system. And so, distance relay, we will talk about that which is just voltage and current at the local bus only. Overcurrent relay, we have already talked about that in details, that can be also applied to the transmission line. We will see later on what is the limitation of overcurrent relay.

Communication assisted different protection schemes and so. So, in overall we will see here that some are unit protection, some are non-unit protection, some relays are principal schemes use communication system. When it happens to the communication system, there is associated cost, longer a line longer will be communication protection channel and associated cost will be more. So, therefore, we see you can say that all the varieties of relays in different transmission line protection.

Moreover, in case of communication failure, the local information based relays become essential and therefore, we can have both unit protection supplemented by non-unit protection schemes for transmission lines.

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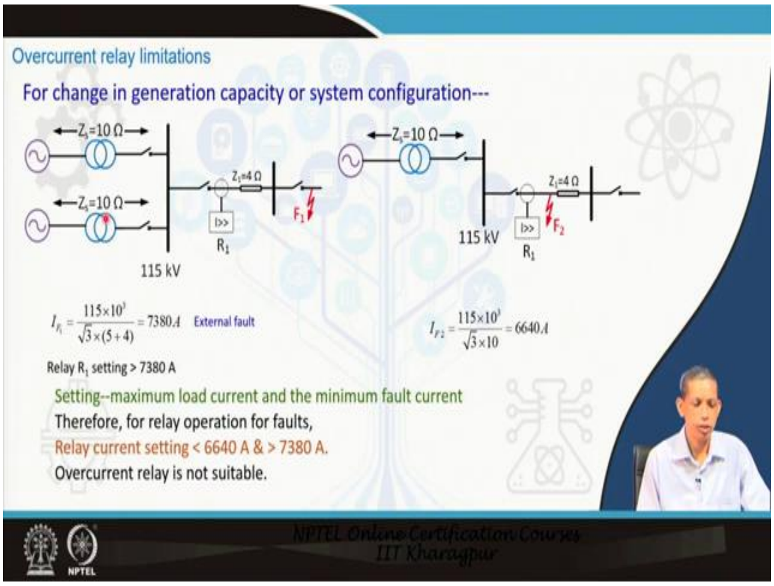

Going to the different protection schemes available for transmission line we see straightforward you can go that how over current principles can be applied as we have learned earlier. That can be suitably applied if the network is small. But generally transmission system networks are very big. That is one challenge, how to have the coordination for overcurrent relaying, that becomes a problem. Besides, see what happens in a network we will see from one by one, what are the limitations of work on relay, why this work on relay cannot be applied in the generic transmission system we will see.

However, to be noted is that overcurrent relay supplement some of the aspects of transmission systems and they are being incorporated but not for in generic with in a coordinated manner. See this system here, so we have 2 connections for this bus. So, that is why these 2 lines are feeding to this bus and this we see that it is connected to a line with sudden impedance and we have a relay R1 here and we are creating a fault F1 which is beyond this line.

So, this leads to a 3 phase fault F1 let us say, this leads to $I_{F1} = \frac{115\times10^3}{\sqrt{3}\times(5+4)}$. So, this gives us 7380 ampere external fault. So, this is overcurrent relay, let us say, now suppose at any operating condition one of the line is out and only this first, you can say that line is feeding to this bus.

Then in that case he could take this fault F2 at this point which is internal to this line beyond this relay. So, this IF2 becomes equals to $\frac{115\times10^3}{\sqrt{3}\times10}$, that leads to 6640 ampere. So, you see that the corresponding current between a current beyond the line at this configuration is somewhat higher than the fault adjacent to the relay, that is very unusual what we have till now seen.

So, now the therefore, the relay R1 setting R1 setting will be must be greater than 7380 because the fault is beyond the line. So, for this section it has to take care primary backup whatever inclusive, so therefore, let us say for this case it should have greater than 7380 ampere. But we see that this setting as we have learned from the overcurrent principle, it should be greater than maximum load current and it should below the minimum fault current level.

Therefore, the relay current has to be that it should be greater than 7380 ampere, let us say this the end of the zone and but from this figure we say that this is adjacent to the relay and it should be less than 6640 ampere. So, this is contradictory, so therefore overcurrent relay principle cannot be applied in such a scenario. So, this is either we are talking generation capacity reductions increment and so, or in terms of the configuration of the system parallel lines or multiple lines connected to a feeder or so.

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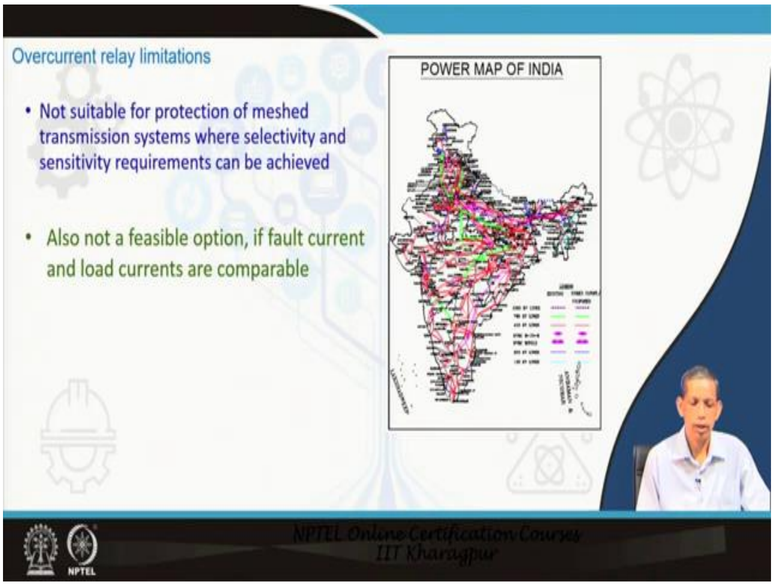

Now, if you think about a nation or any unions then and also the land becomes very vast, then we will find many long transmission lines in the system. So, this is a picture of a connected transmission line in India map. So, we can see different considered voltage levels studied from 1200 kV, 765, 400 kV HVDC links and all these things. So, these connectivity is such that the network is massively interconnected. And in this kind of scenario, the coordination becomes next to impossible between different lines connected base station.

And that you consider that the overcurrent relaying principle is not that suitable for meshed transmission system for such a scenario. Furthermore, if they are the fault current and the load currents are comparable then overcurrent only points limitation. So, from these different limitations, we find that overcurrent relay is not that suitable for transmission line protections which is having massively connected as shown in this map.

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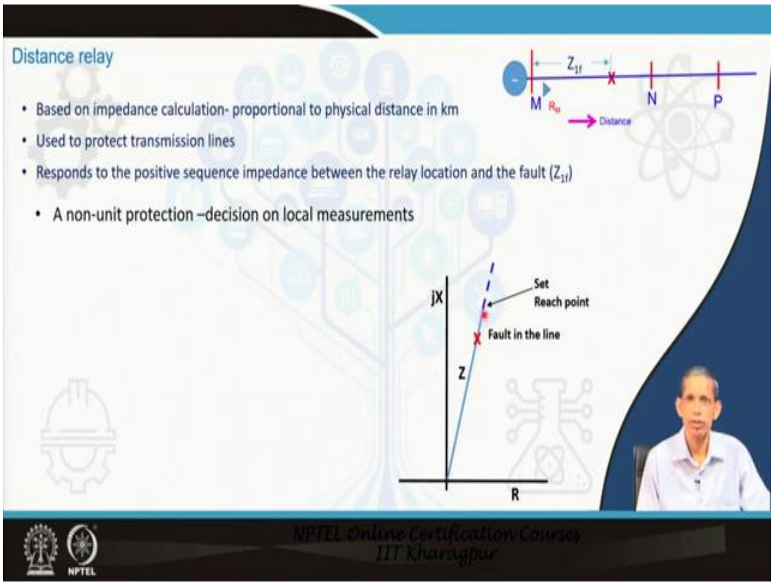

Now, come to now, that distance relay, what is it, how does it so useful, so common in network transmission, network protection and so. So, before going to that, we will go with the basics. Now, say, we already mentioned that distance relay is based on impedance and these we know that the transmission line R L, they are proportional to the length of the line. So, we have per kilometer R or L which gives the series impedance of the line R+jωL.

So, this series impedance of the line is proportional to the length of the line. That means that if we are able to find the impedance that implies we are relating to the physical distance in terms of kilometers or meter. Now, let us consider this simple system, where you have bus M and bus N. So, we are concerned with this line now, and if fault happens to be there at this point. So, relay at this bus is concerned about does it provide the protection of this line and the measurement point is here.

So what we see that what the distance here does is that this response to positive sequence impedance between the relay location and the fault. So, based on the voltage and current available at this point, it tries to find out, rather finds out the positive sequence impedance from the relay point to the fault point and then compares with a set value that you considered then it says that whether the corresponding fault is inside the line or beyond the line and it makes a decision accordingly.

So therefore, using the voltage and current information, the distance relay finds the impedance, positive sequence impedance up to the fault point and then makes a decision whether that fault is inside the line or beyond the line. Furthermore, because this impedance is proportional to the distance, so, it relates to this physical distance of the line also or up to the fault point.

This, such a relay which is only local voltage and current data, so we call it non-unit protection and that is the strength also. Now, coming more on to this, so this relay, because it uses impedance which is a, which you can show in the complex RX plane. So, R real axis resistance in ohms and X in the imaginary axis, the reactance part in ohms. So, this line refers to the impedance of this line, the positive sequence impedance of this line.

So, we now, we can say that something like 80-85 degree the line impedance, so this angle, so it is about impedance of the line and then this you can see that comes to this. Now, what do we say here, we call setting of a relay which the relay compares and that setting is called the reach point of the relay. So, in terms of physical distance, we can theoretically say that MN is the section of concern. So, this MN has a positive sequence impedance.

So, therefore, you can see that, we can say that, based on this we can say that for this relay, we can set a certain impedance and that is called reach point or the reach of the relay for the decision making process by the distance relay. So, whenever an internal fault happens to be there, that fault point may fall on this RX plane on this one. So, the relay finds the corresponding fault here. So, it is less than the set value. So, within the reach of the relay. So, therefore, the relay can take a decision of tripping.

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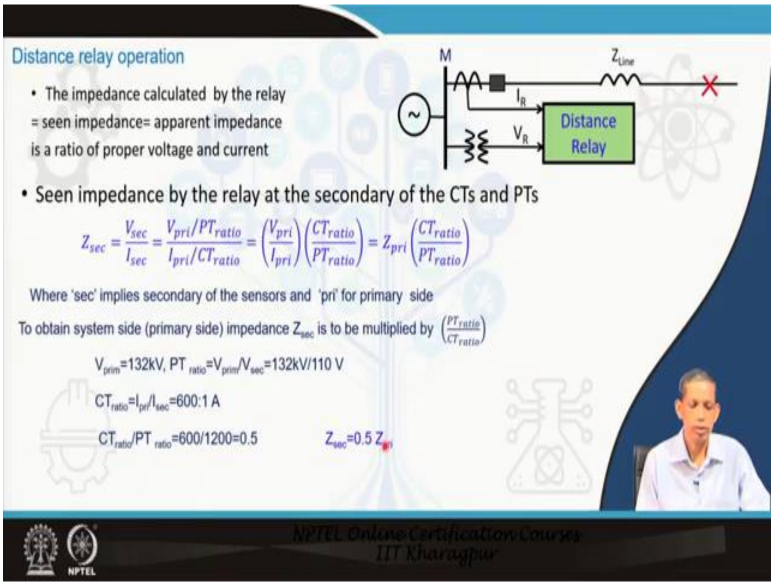

Now, further in our discussion on distance relay, let us see system having like this. So, as already mentioned, the distance relay takes current signal and the voltage signal from the CTs and PTs or CVTs, capacitor voltage transformer or coupling capacitor voltage transformer, as mentioned and high voltage system such as transformers, such transformers are being used. Now, this line and a fault happens to be here. So, relay is to make a decision on the protection.

The impedance calculated by the relay also called seen impedance or apparent impedance. So, we put 2 terms here, seen impedance by the distance or the apparent impedance by the relay is the impedance calculator whether delayed to make a decision whether it is within the reach or beyond the reach. So, these so called positive sequence impedance calculation by this relay otherwise called seen independence or the apparent impedance up to the fault point, is obtained by a proper voltage and current ratio in a selective way.

Now the seen impedance by the relay, because the CT signal and the PT signal at the secondary side. So, if the calculation of the relay is based on the secondary signals of these sensors. So, Z_{sec}, if you are using all the voltages and the corresponding current information as used by the relay then the corresponding impedance seen by the relay, as per the secondary side information, so V_{sec}/ I_{sec}.

But V_{sec} is Vpri/PT ratio and I_{sec} is I_{pri} / CT ratio. So, this leads to V_{pri} where I_{pri} x CT ratio /PT ratio, so Z_{pri} x (CT ratio /PT ratio). So, we see from this that the impedance, secondary impedance seen by the relay is related to this primary or the network side impedance in actual into the this ratio CT ratio by PT ratio. Now, let us have an example small example, how these are related.

Let us say this is a 132 kV system and a PT 132kV/110V, so different countries that have different PT ratio 110, 120 and so. This 110 volt again goes to the numerical relay, numerical relay cannot take directly that level of voltage. So, it scales down further inside it to a suitable level of 10 volt or so. Now, this ratio 132kV/110V is a PT ratio, PT converts the scales down the voltage to such a level. CT ratio let us say consider for this only 600:1. So, 1 ampere CT or 5 ampere CT as per the availability.

So, CT ratio/ PT ratio here like the CT ratio /PT ratio is 600 / 1200 for this one. So, this keeps a 2.5. So that means that the Zsec will be equals 2.5 Zpri. So, Zpri corresponds to the system level of impedance, actual impedance what will be seen during the fault, the fault loop impedance. So, divided by 2 will be Zsec in such a scenario. So, the relay calculates everything because of the numerical platform.

So, if it calculates everything, Z primary then it has to get that , we can say that whatever Zsec it has obtained divided by 0.5 means twice of Zsec. So, in general you can conclude that that to get the corresponding system side impedance, whatever Zsec often to the calculation by the relay should be multiplied by this PT ratio by CT ratio for that.

If most of the testing kits they use the secondary signal in general, so therefore, you can say that in that kind of thing this relay set, relay is being considered set in terms of Zsec then the corresponding multiplying factor here must be taken care. Our numerically it does not have such problem, it can accommodate Zprimary directly.

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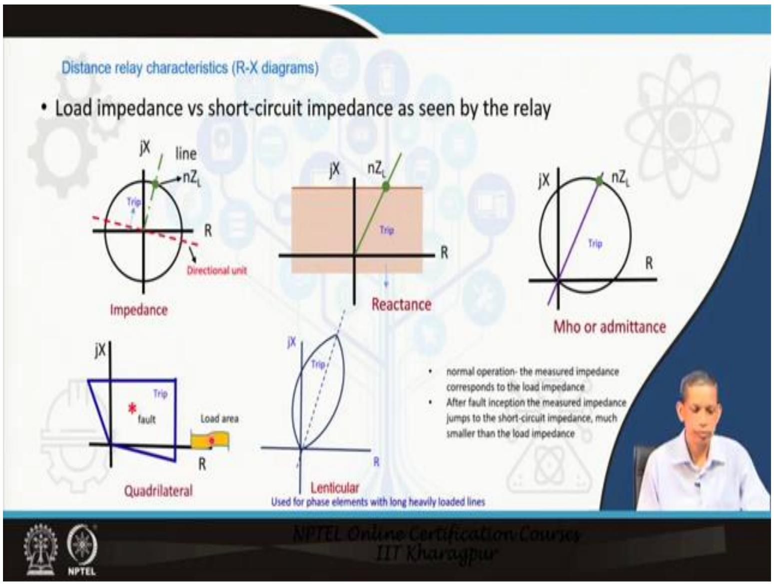

Next, we will go to different characteristics of this numerical relay. So, we have already seen that we can pull the apparent impedance of the distance relay in RX complex plane and the relay can calculate the apparent impedance and then based on the apparent impedance it can take a decision. On this RX plane the distance relay has just different characteristics trip boundaries. So we will see a few of them here. So, see here, you can say the first one is called the impedance characteristics.

So, whatever you can say that setting nZ_L or you can say that this as Z_L for the line impedance, whatever percentage of line or whatever comes into picture 100%, 80%, 90% or so, whatever we like to put to the relay, distance relay, for that setting, say a circle from the origin, success will be impedance we are concerned about. Now, however, when you talk about a fault in the forward direction, then we will see that only this upper half each of required.

So, in this kind of case we require a directional relay. So, that directional relay, well you can say that that this will be the only trip region, if you are looking at the reverse directions then you can see this direction also. So, this portion will have the trip region in the forward direction and beyond this is block region. So, relay it takes a decision for this case that if the corresponding apparent impedance calculated by relay comes here, settles here, then we say that it is inside the trip region, the relay will take a decision.

Similarly for the reactance relay, the X value is set here only reactance it does not bother about the what is the resistance concern there. So, therefore, below this line anywhere you consider the corresponding X value calculated by the relay falls here means it is a trip decision and beyond this is block or no trip decision. Mho or admittance form as the name suggests here this impedance relay you for circle going through origin. So, that has numerous advantages also many relays you this kind of characteristics, we will see later more details on this.

So, if such a for such a characteristics, which is called the mho admittance relay, anything, any impedance during the calculated by this relay seen impedance or apparent impedance calculated by the relay which falls within these characteristics, we get trip decision. How the corresponding trip decision is obtained by the relay we will see later on. The other one, it is a quadrilateral characteristics. So if we see this quadrilateral characteristics, as the name suggested there are 4 boundaries here R and jX. And then whenever you fall, this is the trip trigger region whenever a fault happens to be there, this will be inside and the relay will take a decision.

This lenticular characteristics is similar to you can say that mho but here you can say that the lengths of the curvatures are being used, and that has also certain usage in different applications particularly for long heavily loaded lines this may be advantageous and so. So, we see this variety of characteristics for the distance relay, the characteristic which are required for protection decision and a distance relay may use any of the characteristics, combination of the characteristics or a characteristics in a numerical relay to make a correct decision during a fault.

If the apparent impedance calculated by the relay falls within the characteristics, the relay takes a trip decision, otherwise it remains silent. Now, what happens here, if we think about this load impedance versus the circuit or the fault impedance during, the impedance during the fault, in normal operations, the relay sees the impedance of the load, the impedance of the line in front of it and that is much higher, typically it will be resistive, the load impedance is the load is seen, generally you can say that close to the unity power factor for a transmission line.

So it will fall in this area during the corresponding operating point, normal operating point far away from the characteristics. But whenever a fault happens to be there, then the corresponding impedance become much smaller and then it goes inside the characteristics and relay distinguishes the fault situation from the normal load situation and makes a correct trip decision.

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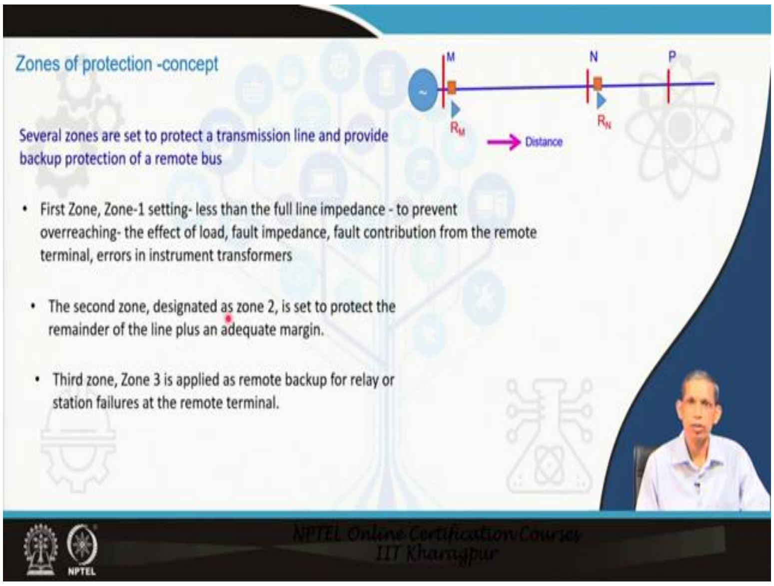

Now, going further the concepts of zones comes into picture, we have already defined zones in initial lectures, the area which the relay takes care for its, for the protection decision. So, in distance relay, we have several zones of protection zones of protection, which takes care of the primary protection as well as the backup protection of the remote bus. So first zone are called zone 1 is less than the full line impedance, the setting for the first zone this RM, we are talking about the distance relay RM which has different zones of protection.

What are those we will like to see here, first zone or zone 1 is less than the positive sequence impedance of this line, while as the purpose of this relay is to take care of this MN as the primary function, primary objective. But in Zone 1 will fix it less zone 1 is instantaneous no delay. If the relay finds from the voltage and current phasors, computes the corresponding apparent impedance and finds the corresponding distance or the impedance to be less than this set impedance, then relay takes the decision.

In the process of this decision process, relay takes the signals from the sensors, there may be error in the sensors from their transient response and so, including their ratio, the prefault current as you have seen earlier also prefault current may be significant and that modulates the fault component of current, so these 2 component these two combinedly will be observed by the relay.

So, that also may be, there may be an effect of that. The fault impedance if the impedance, if the fault happens to be associated with an impedance after resistance and so, then also the corresponding seen impedance or calculated impedance by the relay will be a different one.

So, there are other associated errors accounting all these errors and the so-called uncertainties, we say that will not allow the corresponding relay in zone 1 which is instantaneous to take trip decision for the full length of line. Because, if we allow that, if fault happens to be beyond the line also this relay may take a decision which is not desirable, because load here and load here may not be sharp in that situation.

So, therefore, what is being done, that we leave some of this section, which is because of this uncertainty of this different instrument so on and so. So, that is the reason that the zone one setting is less than the full line impedance, positive sequence impedance. Now, if something is left out, then the protection has to cover that. So, therefore, we talk about a second zone and some at zone 2 is set to protect the remainder of the line.

But to ensure that at zone 2 nothing is left out this zone is extended beyond this line. And because this is extended, so therefore this is having a slower response, that is having a slower response unlike zone 1. There is another setting third zone, zone 3 that takes care of the corresponding remote, takes care of the backup protection for the remote bus relay in case of station failure. Like think about the situation we have already enumerated in case of overcurrent relay also.

If this breaker fails, then a fault in this line will continue. So therefore, in the upstream this site, this breaker must take care of that. So therefore, this relay has to read that situation. And as a backup to this you can say that perspective, this relay should operate. And that is the reason zone 3 takes care of that, not only breaker failure, the relaying also fails, the connection between relay and breaker may also fail and so on.

So, therefore, we observe from these in basics require zone 1 to take care of this protection of MN, instantaneous protection, but, because of uncertainty we do not allow this relay to reach up to N, some percentage is left out to take care of that zone 2 is assigned, but zone 2 ensures that the whole section is covered. So, we extend that region and therefore, that becomes a slower one. And then Zone 3, we say to take care of the backup for the next line section, the breaker, the substation failure and so, as a backup. So, these 3 are very commonly being used in transmission line protections, 3 zones of protection of transmission line.

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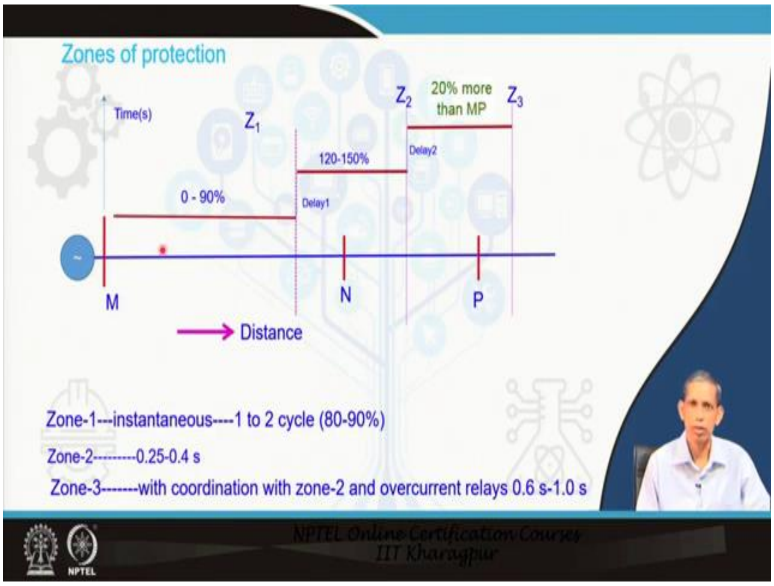

These zones of protections are called step protection. Why step protection, if you see this one, same MN and NP section let us say we are considering and we are bothering what only relay at here. In this diagram, we are showing only the relay RM located here. That RM has 3 zones as we have already enumerated first zone, second zone up to this and the third zone. third zone is as back up, second zone you can say that takes care of this section, primary protection, first zone, primary protection.

Now we see here that this first zone covers up to 90 %, this one covers rest of the percent. To ensure that no fault is left out from here we extend this reach of this zone2 to any fault in NP section also must be taken care of by the RM relay as a backup. So, therefore, we extend the corresponding zone 3 at least up to P to ensure that no fault is left out, we extend it to furthermore, 20 percent more than the corresponding M to P sections. So, this is what we see from this, that we have zone 1, zone 2, zone 3.

Zone 1 Let us save up to 90% of the line from R_{MN}, zone 2 is 120 to 150 % to ensure that nothing is left out from here. Note that in books you will find also that some of the faults of you can say that this portion is also taken care by this. But here you can say that another, you can say another set of you can say that relay circuit breaker should be available.

That relay has a primary objective to protect this line section, that again will be instantaneous. So, the corresponding zone 2 of this must operate because that will also see this fault here must operate after the primary at N operates for a fault here. So therefore the zone-2 in slower.

And that is the reason this is instantaneous, we delay the corresponding zone-2 operation typically by a few cycles, time of 0.25 to have 0.4 seconds and so on. Now, say faults in this section will be taken care by either zone 1 or zone 2 if they fault happens to be here, the relay at RN will be taking care of zone 2. So therefore, the zone 3 at RM, the zone 3 at M was the corresponding RM, this is what we have drawn, so that zone 3 should act after zone 2 of RN left.

So zone 2 RM will be a similar characteristics, similar kind of step for, so therefore, we say that the zone 3 should be further delayed and typically that is around 0.6 to 1 second kind of thing and has 50 cycles or 50 hertz system or 60 hertz system or 60 seconds or so. So we say that the relay, distance relay RM, we will have 3 steps relay characteristics, first is zone 1, say up to 90 percent, zone 2, say up to 120 to 150 percent of this line section MN and zone 3 M to P, more than 120 percent of MP section on here. And that leads to complete you can say that three-step protection for RM. Similar step protection will be available at N and P and so on.

So, this is what zones of protection, step protections. Note that this, this axis is time axis so we have time here, these are the more and more time for zone 3 as compared to zone 2 and zone 1. This time is circuit breaker opening time, relay decision time. So, typical this time is less than 5 cycle or so. Relay decision time is typically 1 cycle and so.

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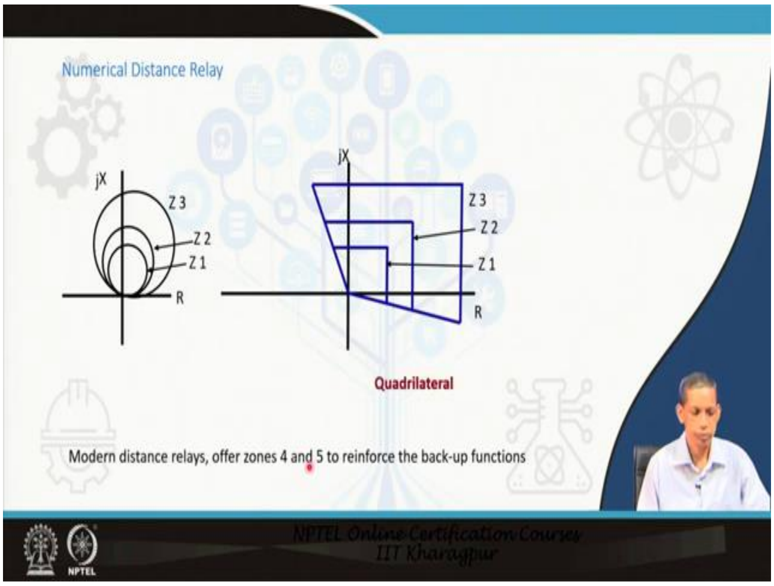

Now, we see that in numerical distance relay, typical curves that is being used, set of curves that is being used, we have more relay more characteristics here and this is quadrilateral characteristics already we have enumerated. So zone 1 say 90 percent of the line, so this is zone 1, zone 2, 120 percent of the line, this is zone2. And then we have zone 3, extended beyond the next line is zone 3, so this is zone 3. However in addition to these 3 zones, modern release, they provide zone 4, zone 5 and so to provide backup functions applications furthermore.

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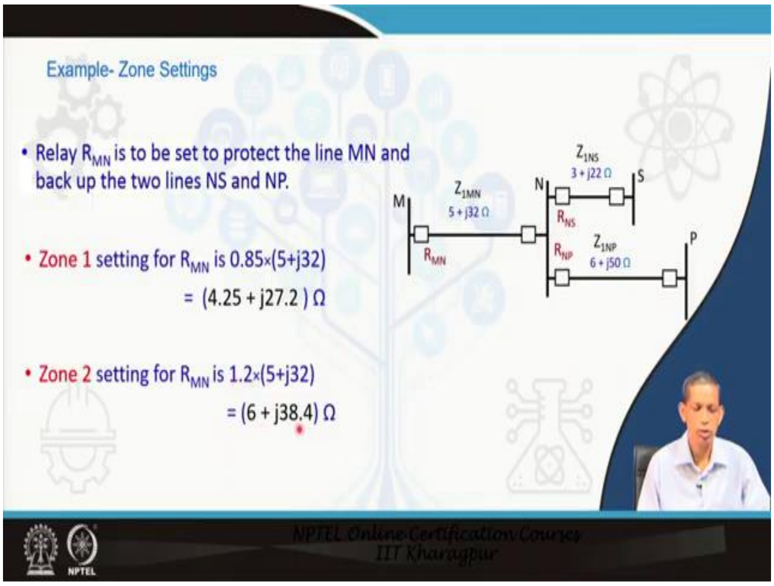

Now we will go to how you can set zones, we will see examples. So, zone settings, let us say we have a 3 lines connected like this, we have MN section, NS section and NP sections, 3 sections are there. The positive sequence impedance of each line is provided here, this a longer line, this is shorter line, longer line. Relay RMN is to be protected for you can say that this section. So what we will do here that zone 1 setting for RMN is say we are going for 85 percent, as I mentioned it can be 0.8 to 0.9, 80 percent to 90 percent.

So, here let us say we are having a setting of zone 1 85 percent, so 85 means 0.85×(5+j32), that gives you 4.25 + j27.2 Ω. So, this is the reach of the relay R_{MN} in zone 1. Now zone 2 is 120 percent of this line. So 1.2×(5+j32), so we consider 1.2. So, the settings will be, the reach of then to will be 6 + j38.4 ohms.

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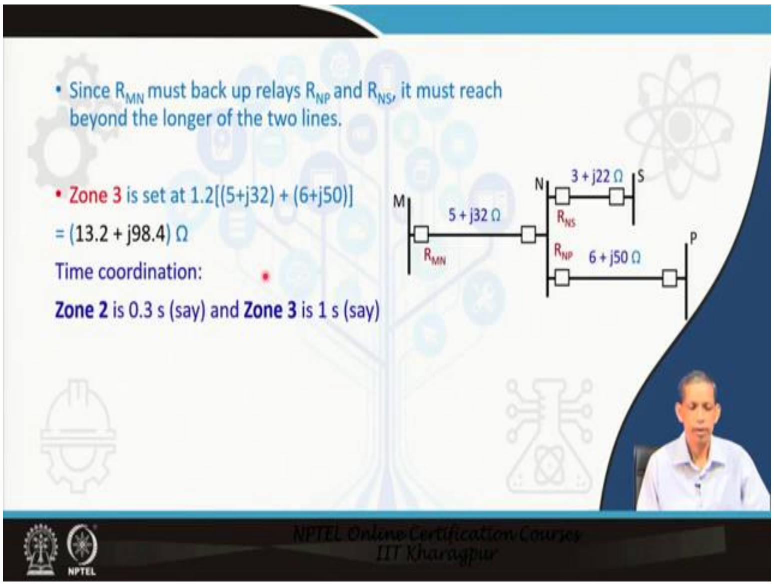

Next can say that, we consider our zone3. So, the zone3 business for the R_{MN} will be taking care of this line and line connecting in the next bus. But we see your one is shorter line, the other is longer line. So, if we cover longer line, the shorter line automatically comes under that. So therefore, we say that we have to consider MN and NP, automatically NS is inclusive of that. So, therefore, we consider a longer line is our target. So [(5+j32) + (6+j50)], that is your M to P.

And this you can say that 1.2 times that it is ensured that this both the sections are taken care of so that all faults here also had been taken care of by this relay R_{MN}. So multiply by 1.2 or so, these are not fixed, these are flexible depending upon the situations and then that gives you can say that a setting of 13.2 + j98.4 ohms for zone 2 settings. Time correlation, suppose for zone 3 we will say a delay of 0.3 seconds, for 50 hertz system this is 15 cycles.

Why take this zone 3 cold nation time correlation of 15 cycles, we have already discussed in overcurrent also that the other relay at this must clear in the zone 2, breaker opening, relay decision, calculations and all perspective we can say that are being taken care. So, therefore, we consider we will talk about few cycles, leaving few cycles for that perspective. So, this is similar to the what you have studied in the overcurrent coordination or so.

Zone 3 is further delayed, so here it is set at 1 second. So, this is what we learned, that how to have zone 1, zone 2, zone 3 settings including a time step considered distance relay principle for different lines.

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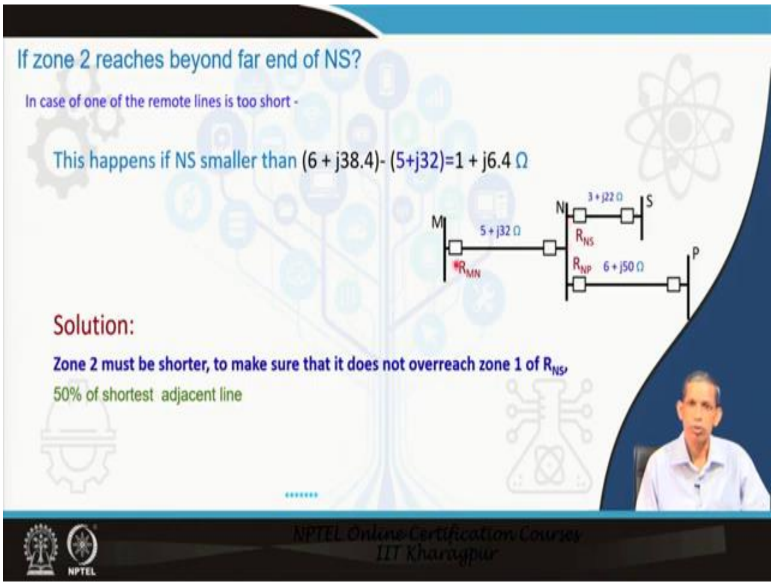

A question comes, you can say that if zone 2 reaches beyond far end of NS. Now, suppose you can say that we have flexibility of zone 2 setting 120 times, 150 times of the MN. If it is 150 times or so, we can say that that you can say may cover from here to beyond this also, then what, then there is problem. So, in case one of the remote line if too short and then you can say that NS becomes too smaller. Now smaller means, if the NS section like you can say that the corresponding impedance is (6 + j38.4)- (5+j32).

This is you can say that 120 times minus this line so, that you can say that the rest is 1 + j6.4. If the corresponding this impedance becomes smaller than this, then the corresponding relay zone 2 you can say that relay will reach you can say that beyond zone 2 beyond this. Then what will happen to the section beyond this? For that also the corresponding fault will be seen by this.

So, before the corresponding zone 2, zone 2 of beyond S operates and this may also operate. So, that will conflict will have a conflict of interest. And further you can say that this is not allowed. So a solution how do we get, that the zone 2 must be short out to make such that it does not overreach the zone 1 of NS. So, we say that the zone 1 of NS is not you can say that overcome. We can say that zone 2 of the can say that NS, if fault appears to be here, this relay also will see and this will also see, so it will go for a protection decision.

And then you can say that it is unwanted, and then you can see. So what is being done that. In this case, you can take a very shortest length 50 percent of that plus this line impedance. So that may be a guide lining factor for this one. In case of zone 3, we take the longest line, in case of zone 2, we can take the shortest line, 50 percent of that for avoiding you can say that such protection issues of zone 2 of here and zone 2 of here. Thank you.