Power System Generation, Transmission and Distribution

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Lecture No. # 17

Compensation of transmission lines (contd.)

Welcome to this class. We will continue the topic of compensation of transmission lines, which we started last time. Since it is a very important topic as you all know, that compensation is not only in power systems, it is in any system. Even for example, medical, see if you are having deficiency of vitamins, they give you vitamins, scavi vitamins there is another problem, they sort of try to compensate it.

Similarly, if you do extra work in your real life or in your job, they try to compensate by over time or some allowance. Similarly in your student age, if you do certain extra NCC, NSS they give you certain points you know and so on. So, here what is compensation? You are trying to compensate for any fall, any shortage, any shortfall in either frequency or voltage. To some extend it is self regulating, like your must have heard eye flow or conjunctivitis, thus it is self reliability. It will get cure, only thing is what your treating is symptoms. So, you do not get in further secondary or tertiary infections, otherwise it will get cure in, like cold, this safe it you take medicines, it will be alright in 7 days, if you do not take, it will be alright in one week, so, similar thing. But here beyond the limit it does not remain self regulating. Why do you say it is self regulating? The frequency goes down or voltage goes down the load also goes down. The load is proportional to sometimes knowingly, intentionally will reduce frequency. That is the standard technique in India to compensate for extra load. Are you aware of this? Since frequency goes down the speed goes down, as speed goes down, the load goes down. The load is proportional to speed, other speed square or speed or depending on which load you are talking. That in that sense it is self regulative. But self regulation is only possible within very short range. If it is a deviation is large, then there is no self regulation, then you have to treat it, you have to do medicines you have to do so many things. And what is this medicine? It is a compensation. It is series compensation or shunt compensation and

we are talked about it earlier. Now this rotating var generator we have already done, we have proved this formula Q c, this was rotating var generator resistance 0 adjustable.

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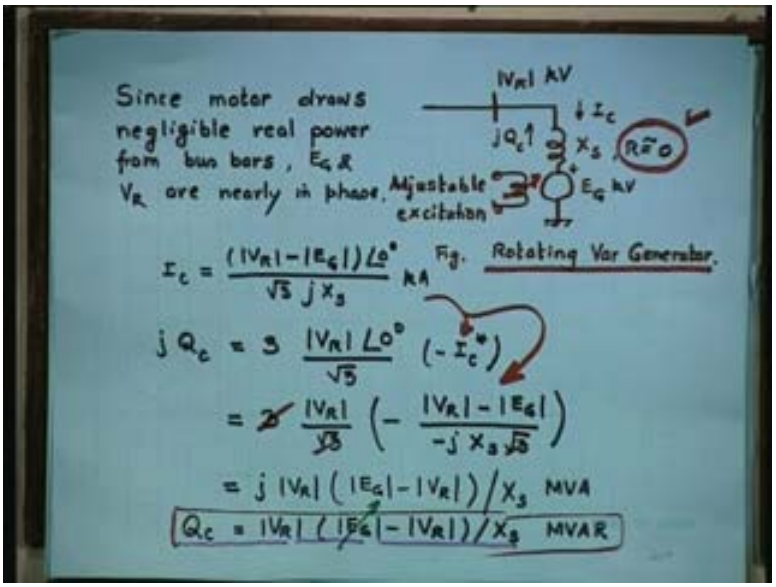

So, excitation that is part you are going to control, and if you control excitation naturally, your voltage will change because E G this is variable. So, V R goes down here to put E C R, but luckily find out earlier, here V R also goes down and this is called self regulation, requirement of Q c will automatically also go down.

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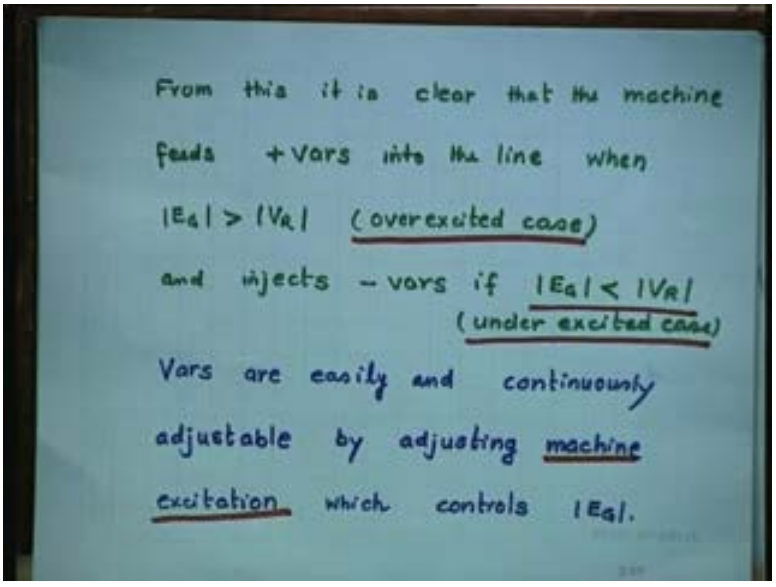

So, as you know the over excited case, the E G has to be more than V R, under excited case, E G has to be less than V R and normal excitation both are equal. So, vars can be easily control, continuously adjustable. In fact, the whole new field has been carved out of this important topic how important is this there is a regular course doing on in electrical engineering curriculum on facts there are books Hingorani is the best books so for, then there Indian book, Hingorani is also Indian incidentally another two Indians have written wonderful books on facts, that is by Mohan Mathur and Rajeev Varma. So, these two chaps both are in Canada, the book is very good and this is the very thrust area now a day facts. There is a flexible a c transmission and once you have a flexible a c transmission as you go along the line, there is a automatic compensation, because of the thanks to the solid state control the power electronic circuitry i g b t are used now a days. Now I do not think you are going to cover full of facts, but any ways is few things we can cover later on at the time permits, because now roughly a month is left once your minor is over more than a month left.

We have had a few observations on dynamic compensator, this is continuously adjustable, your dynamic, but it is static, you have to shift from capacitors to (( )) of inductors. Now that point also has explained to you which is less sensitive and dynamic compensation is better as for as the when there is voltage collapse, the collapse means, the suddenly voltage goes down 0.5 per unit, but is 0.9 0.85 0.95. Even transformer is enough, which we already studied, the tap changing transformers. You do not even go to SVC or SVS, but at times there is collapse, what happens on first generative 2002 or recently US even UK?

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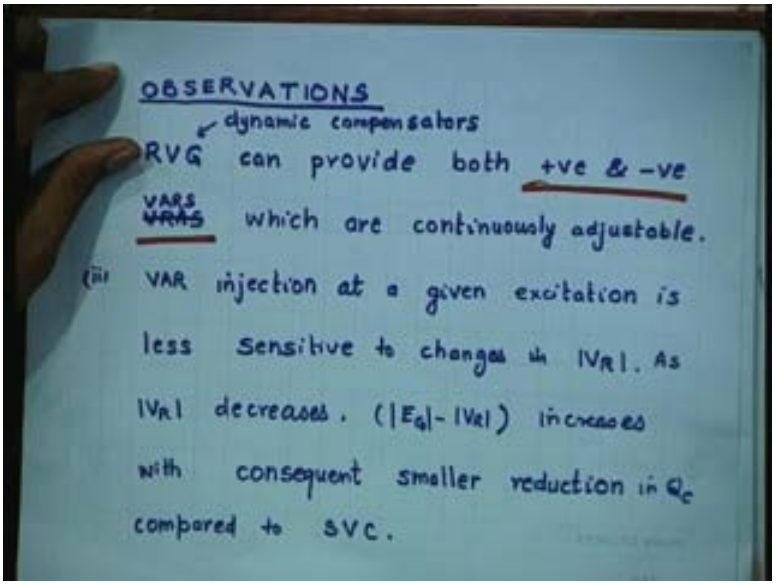

So, this collapses are taking place all over world, do not think not only in India, and the best collapse is of 60's. US, best or worst, whatever you want to call it. Then there is a 78 French collapse, two third of France was out for several hours and we had one collapse an 24 July 1984, it was Wednesday. So, those days Chitrahaar used to come at 8'o clock, even now it comes. All whole India was (( )) there was no cable, only Doordarshan. So, they used to look forward to Wednesday and Fridays, chitrahar days and Sundays, one picture day. So, suddenly there was dark whole North India. So, those things could be avoided, it if you have proper compensation, but only avoided, you cannot completely rule out the possibility..

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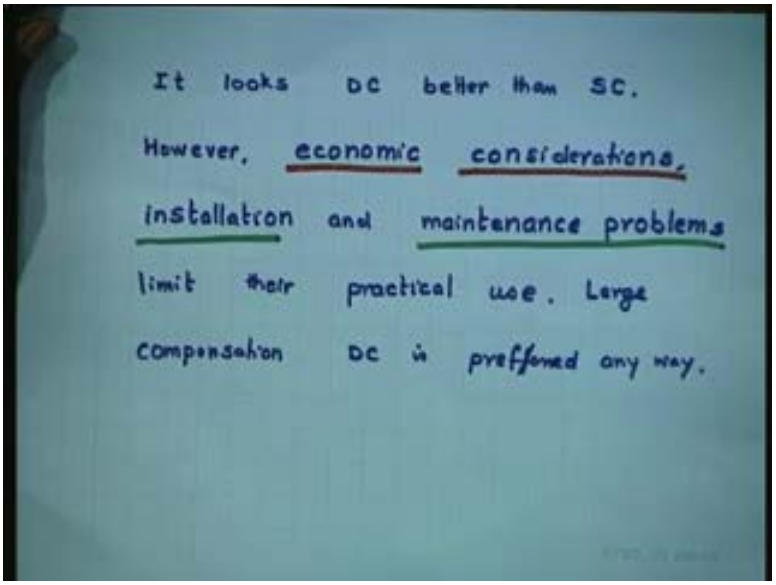

So, there are several consideration economic, installation, maintenance, all these things we have talked and though DC is better than SC, but still we have several problems. We have money problems, maintenance problems, installation problems. So, there is always plus and minus. Whenever such question is asked which method is better. So, you cannot absolutely which method is better, some method is better in circumstances, you can go to any hill station, walking if you are young enough, as you are by bus, by auto, by car, by taxi and lift in 3 4 instalments, if you do not get direct lift, but then which is better, it depends on how much time is available to you, what is your status, what purpose you are going and so on.

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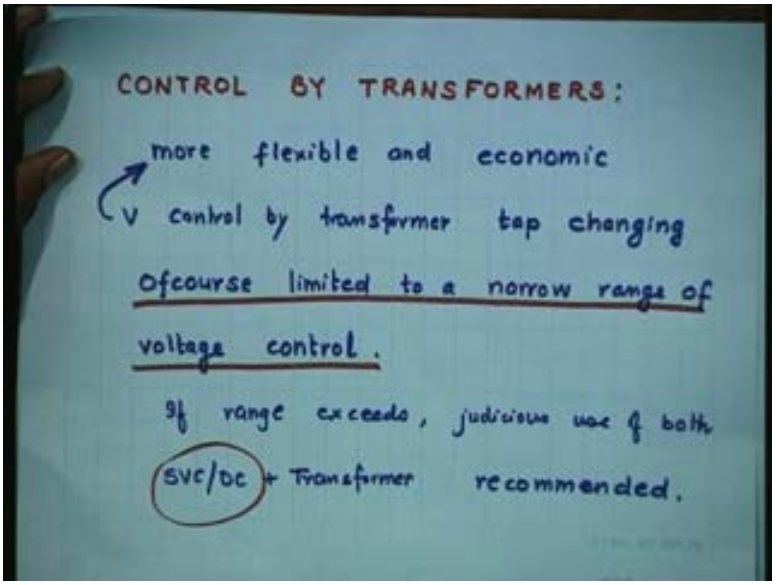

So, there is no unique answer to any optimization problems. These are all optimisation problems. You also study the control by transformers, of course, is more flexible, it is right there, you are not spending any money to purchase transformers, only taps are also there, whether you like or not, each transformer has taps. So, but limited range again. So, if you want wider range again you have go back to SVC or facts and all those devices, but transformer does serve a purpose when it is small variation. Of course, you can play with both the sides taps and always better to increase the sending end voltage itself so that when drop takes place it is back to normal. So, that is the strategy in having taps on both the sides, this are also explaining and this is now done on onload tap changing under load earlier it choose to be off load and now it is on load, so individually you can control the voltage.

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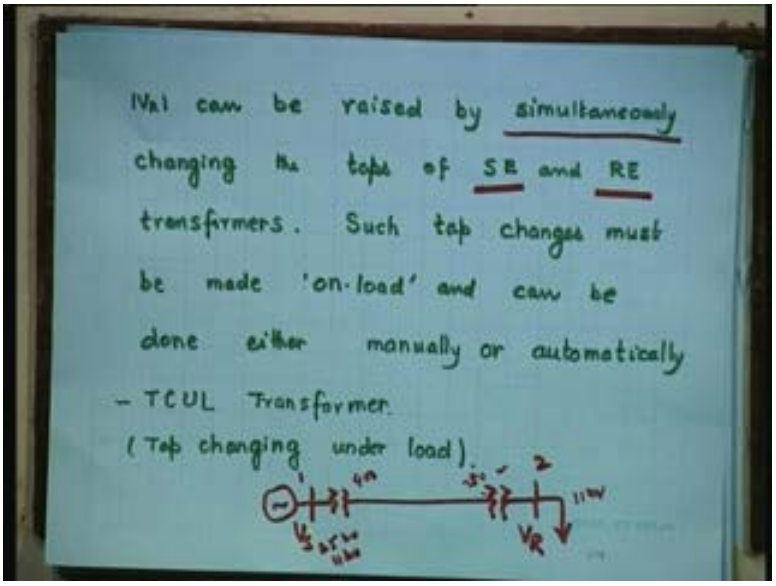

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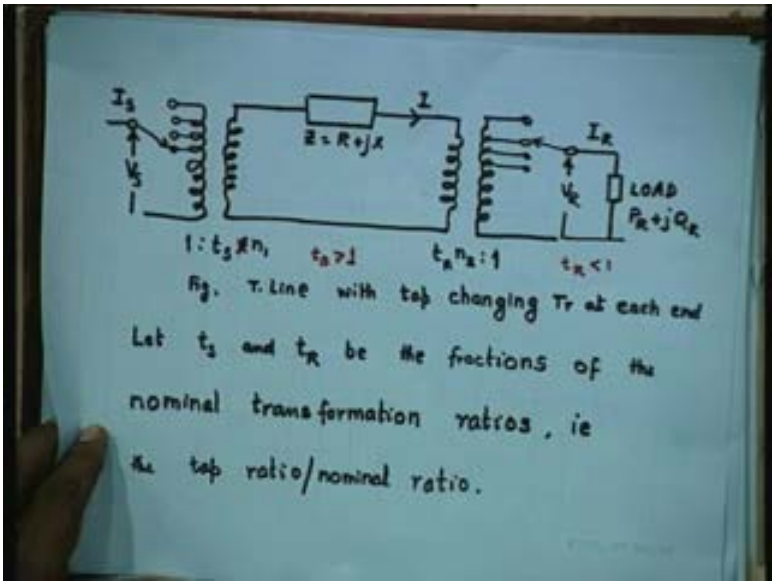

Then we have done some sort of derivation and this was the equation, this is t S more than 1 t R less than 1 and you can design what sort of values you want for t S and t R, depending on a particular situation. This was the equation for delta v, which we have already proved earlier and a transformer with nominal ratio 3.3 kv to 11 kv when tapped to give 12 kv with 3.3 kv input then t s value is 1. 09. Otherwise it will become 11. Since it is 12, so you have to the value of t s and the value of t s in this case has come out to be as it is more than one always we have just shown and therefore, this is the Kirchhoff

voltage law and this is the value of deviation and this again you can write that equation substitute the value of delta V here.

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Interconnection, what is interconnection? Why do you want interconnection? At one place you are talking about distributed power, disperse power and another place you want talk of interconnection. It is because they are two different issues. See you have treat high blood pressure and low blood pressure in different way. The low blood pressure if you are suffering, then the requirement to eat something more, because there is weakness, get giddiness, you may fall down, and if it high blood pressure, then stop salt, do not take fried things, do not take oil, 5 white poisons. You know what are 5 white poisons? That is why I am saying you do not follow US in toto. You follow only in terms of bad things like coca cola, m t v, v t v etc etc. 5 white poisons are salt, sugar, butter or ghee, whatever you want to put it, eggs, rice. These all 5 changes, we will, of course, there are South Indians, there are Bengalis do not take rice , because rice is their primary food. So, but anyway, because rice is having sugar, it is sweet, that is why you like rice, here you take rice to fast time to do get the chapatti. So, there is a compulsion here but other place there is no compulsion.

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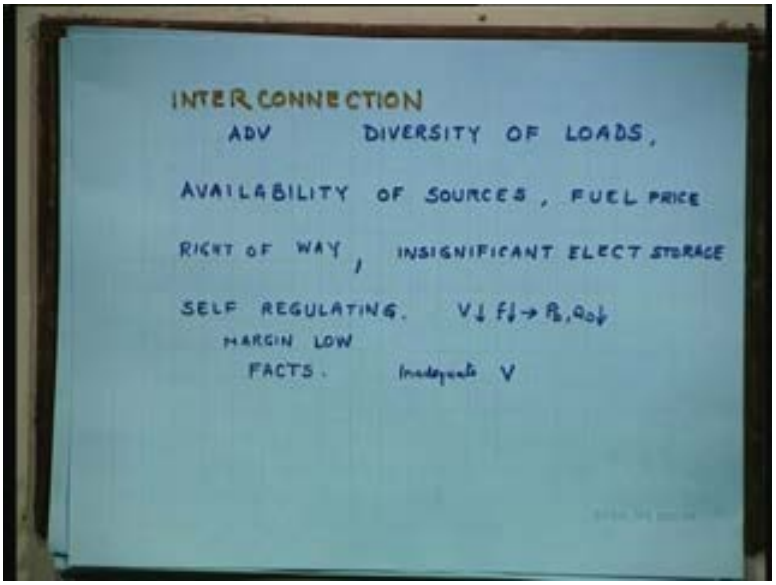

So, interconnection is required and will continuity to be required, as long as you have big network, we have big countries, like India, China, United States of America, Russia. So,

you have to reach every corner and so, grid has to be there. And you cannot have for example, train for from Delhi for each station, Delhi to Panipet separate train, Delhi to (( )) separate train, Delhi to Gurushetra separate train, Delhi to Ambala separate train. No, there will be one train going to either Amristar or Chandigarh and on the way you will have all these stations. So, you cannot use the story of distributed power or dispersed power here, just because it may be convenient to all Sonipat people as they can all sit nicely and go to Sonipat, may be there is one or two locals local trains, but all trains cannot be like that, if you have to have other stations on the way . So, similarly you cannot say I will feed power from Badarput to Sonipat separately, Badarput to panipet separately or another station it panipet to feed panipet consumers. So, what instead you will continue to have big power houses like you have or also put thermal stations and we need an network to evacuate power from such big generating station to any consumer, any node, any load. What were the advantages? Diversity of loads. Diversity factor if you recall we define in very early lecture, that is, even if you have 4 fans in your house, only few or either electricity free or your mad, you will start all the other 4 fans simultaneously even if you sitting on one particular room. If all the 4 members are family are sitting separately are not talking to each other, working their own work, then fair enough, after all they are there, they are there to be used, but all of you are watching T.V or you are entertaining the guest, then that does not make any sense, if you want to start all the fans of the house. So, there is a diversity factor. The sigma of all the connected load upon maximum load coming on the system is definitely going to be more than one and higher it is better it is; because that means, your conserving power, you are saving power, you are using it judiciously, for example, these tube lights, it is there, they are not perhaps serving any purpose, may be here it is serving, but it is on ordinary class room, since you are only 8 persons and if you start the whole lights of class; that means, you are not following the rules of energy conservations. You do not need all these lights. You see what we do, why how we are not following energy conservations and then saying there is an energy shortage. You see any office room, they will have windows open to sea, open to sky, open to outside, they will have thick curtains and use all tube lights. Why? You remove those curtains. Have the curtains, I am not against curtains, but blinders and let the day light come, it is good for your eyes also and you are saving how much amount of power. Even if you are not pain at least eyes are yours I tell when you go for a good meals no doubt it is free,,, but body is yours the body gets spoil tomorrow if you are to visit somewhere too often is not good for the health. Availability of sources,

now sources may be available, God knows where. So, god has not given you sources at the place where the load is. God is also very naughty fellow you know, he does not give everything to everybody. See highly everybody. So, perhaps you will have some flaws, some minus points, some plus points. So, sources are given separately everywhere by nature. If you do not believe in god, call it nature. Then there is no argument. So, nature has not given you everything. Sources are The whole coal is in eastern part of country and the eastern part of the country is not developed Bihar Orissa, the poorest district in the India is Kalahandi. Anybody from Orissa here? Am I right? State also there is tough competition Bihar and Orissa which is more backward? It is neck to neck fight going on. But poverty, everybody talks of poverty elevation and things like that. And the loads are always there in so called developed states prosperous states. That is why they are prosperous. So, we need power to be transfer and that is why we have interconnections.

Fuel price, now fuel price, why you are going for multiple fuel cars, you see that now buses c and g you can shift to diesel, even this auto, anytime they shift any c and g, he stops as it why (( )) now shifting to the diesel, why, c and g finished. So, there is a multi fuel you know, similarly here also, and power also, you have coal, you have diesel, you have petrol, you have so many things, you have oil and nuclear. So, like p v r. Here also now p v r going on, since p v r you go 4 shows different shows are going on in four places. Here also small, small 4 units, each using different fuels. So, your time to do is sort of optimization.. Is another important area for your M tech thesis or minor project or major project is fuel substitution. What is going on in IC engine, of course, none of you are mechanical engineering, they are substituting alcohol for petrol or diesel, they mix it even petrol, this first country in the world, where they successfully used alcohol as a substitution for petrol, the optimum mix and the cars are working. Similarly in our IC engineering lab, we have another IC engineering lab in mechanical engineering, and they are doing a wonderful work and trying to use a scooter and car driven by alcohol, only danger is driver should not drink that alcohol while driving. So, it has to be mixed somewhere else and given in a mixed way, it should not be allowed to mix at home otherwise you will never get mixed. So, this is the fuel price at varies , you will be surprised the petrol price is not same throughout the country, like post card, like your envelope, postal charges, even in banks, different banks are different interest rates. So, it is called open economy, it is called market driven forces. So, it depends where I should use fuels so that it is cheaper. So, coal prices also vary from place to place, where I am

getting coal from. So, this is another issue which is to be debated or researched on which fuel to be used where for power generation. Right of way is another head ache. It is highly in its place. If you go to Newyork, or if you go to even Bombay, and you know the reclamation of land from sea, that is going on. And new Bombay is separate set enough now, because there is no place in the old Bombay, original Bombay, whatever what you like. Here also the required power you need transmission line, cable speed very costly. Newyork is the only city in the world having the biggest cable network because there is no place to have overhead transmission lines.

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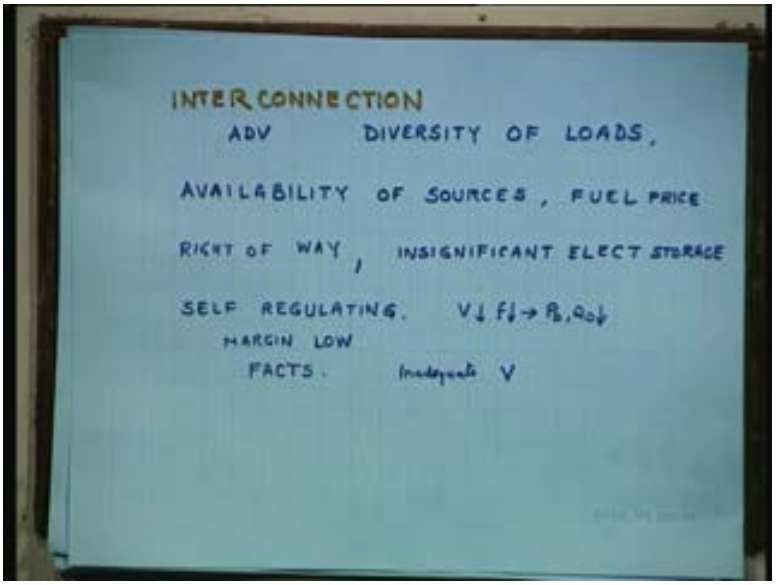

So, right of is another headache, that is why transmission sector is lagging in generation sector. In 75, the government of India felt the high generation, but they have no transmission, you to you quit the power is not needed in circular, that is why NTPC came, National Thermal Power Corporation and later on they found at it is again giving more importance to generation, it was broken into two parts, and power grid, the name itself was grid. So, they have to only work on transmission and not an generation, which is left to NTPC and NHPC for hydro. Similarly nuclear board is separate, similarly m n e s is there. Self regulating have already told you. v and f goes down. p d q d also goes down. Margin of course is very low as I said and similarly facts, we will talk about facts later on if time permits. And whenever there is inadequate voltage, most of the time 99 percent time, it is voltage sagging, it is voltage going down, it is voltage collapse and voltage stability has became very important topic. In fact, every place one Ph.D thesis is

going on voltage stability and even today at least 2, 3 Ph.D thesis is going on in IIT Delhi E department and energy studies on voltage stability. There are two very good books have common voltage stability. One is by Tailor another is Taylor and other is Hudson, the references is given in the book in the new book. I hope by this time library must have got one copy. So, you can have, lay your hand on it, read it the chapter on voltage stability for your interest, whether you will do it here or not, it depends on time. So, it is roughly half an hour over, will talk about your preparation. So, will continue on next Tuesday morning, compensation topic, you finish that and next Tuesday is the examination.

Any question so for? Whatever you are done you practically review situation or compensation whatever you are done and in a way to help you in the minor.