Power System Analysis
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Lecture - 60
Power System Stability (Contd.)

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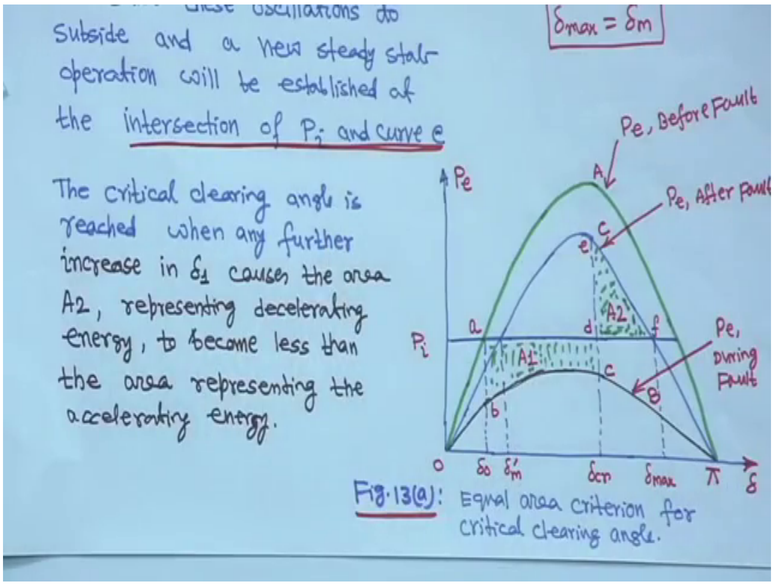

So, now, we have to make A 1 is equal to A 2, right, area A 1 is equal to area this see A 2. So, and you have to find out delta c r. So, what you will do look before proceeding further A is equal to that original graph P is equal to P max sin delta that means.

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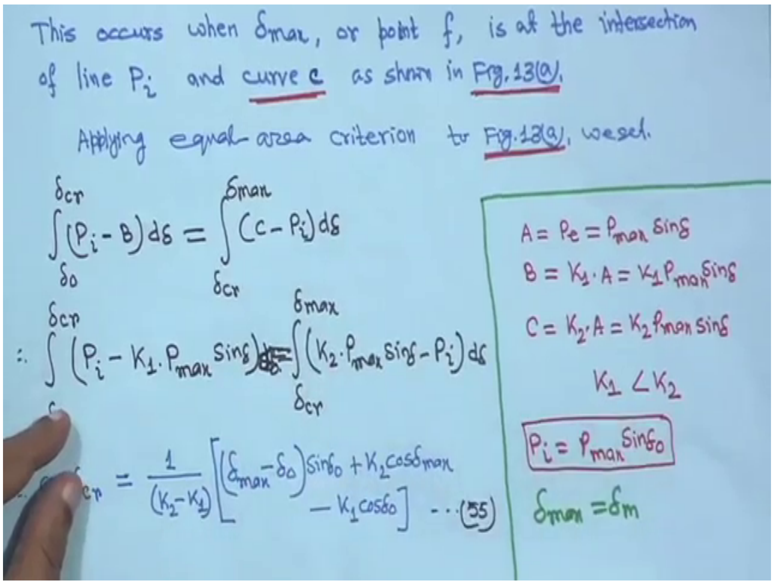

This graph the green color one, this graph now you let the graph b that is b that is a black one, this black 1 b 1 b is equal to say some constant K 1 into A; that means, because this your this an A is equal to P e we are writing here because graph a is equal to P e. So, it will actually K 1 into P max sin delta later will see that K 1 K 2 all can be obtained and this graph C; that means, your this one this is graph C, there should listen one thing, there should not be any confusion this is graph C and this is at point c. So, there should not be any confusion, right and this one graph C is equal to K 2 into A is equal to K 2 into P max sin delta. So, say and K 2 is greater than K 1 because this graph C, if you see this power is always greater than your what you call this during I mean post fault or after fault this power curve always above this graphs.

So, K 2 si greater than K 1 or otherwise K 1 less than K 2 and at delta is equal to delta 0 P i is equal to that is P i P i is equal to P max sin delta 0. So, at delta is equal to at this is the point green color that a point P i is equal to P max sin delta 0. Now that area A 1 is equal to A 2 means that is you take delta 0 to delta c r because this is area one you have to intricate. So, intricate delta 0 to delta c r, then this is your P i graph. So, this is P i minus the curve b; that means, this curve this curve.

Curve b P i minus B and B is equal to K 1 into a that is K 1 P max sin delta will come to that is equal to this area a 2 that is limit integration delta c r to delta max integration delta c r to delta max, then C minus P i this is the curve c and minus this line P i this P i line.

So, C minus P i d delta so; that means, delta 0 to delta c r P i minus K 1 into P max sin delta; this is d delta actually this is into d delta, right is equal to delta c r to delta max c curve is equal to K 2 P max sin delta here it is. So, that is delta c r to delta max K 2 P max sin P max sin delta minus P i d delta. So, if you integrate and in this expression if you substitute P i is equal to P max sin delta 0 and i repeat delta max is equal to delta m. So, if you substitute here P i is equal to P max sin delta; that means, intricate and simplify you will get cosine delta c r is equal to 1 up on in bracket K 2 minus K 1 into delta max minus delta 0 into sin delta 0 plus K 2 cosine delta max minus K 1 cosine delta 0 this is equation 55, this one you will get it right that this is the from which you can find out what will be the delta c r. So, this integration i am not showing this is easy. So, you can make it of your own simple thing. So, next is will take an example now.

So, I think whatever mathematical derivation was there everything is there for this course perhaps, it is over, right perhaps, it is over as far as theory is concerned and now will come to 2-3 numerical; good numericals.

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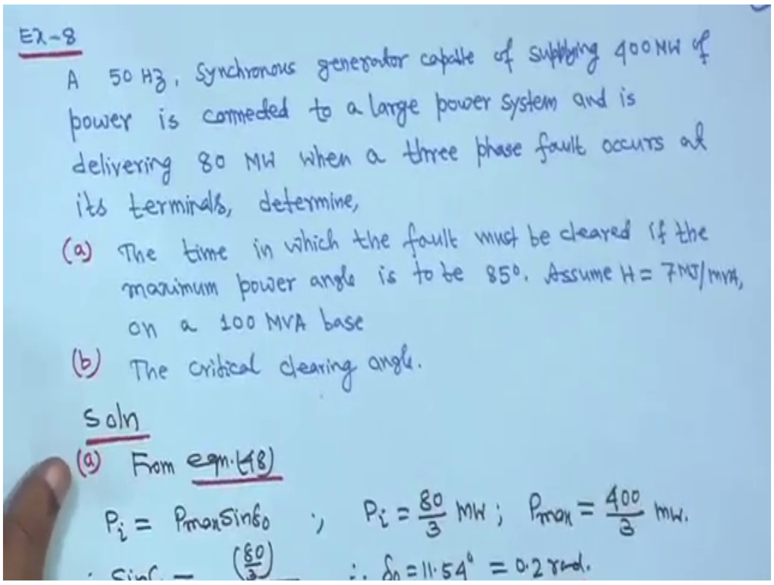

So, first one is look at that first one is that example 8 a 50 hertz synchronous generator capable of supplying 400 megawatt of power is connected to a large power system and is delivering 80 megawatt when a 3 phase fault occurs at its terminals. So, determine the time in which the fault must be cleared if the maximum power angle is to be 85 degree assume H is equal to 7 mega joule per m V a on a 100 MVA base b the critical clearing angle.

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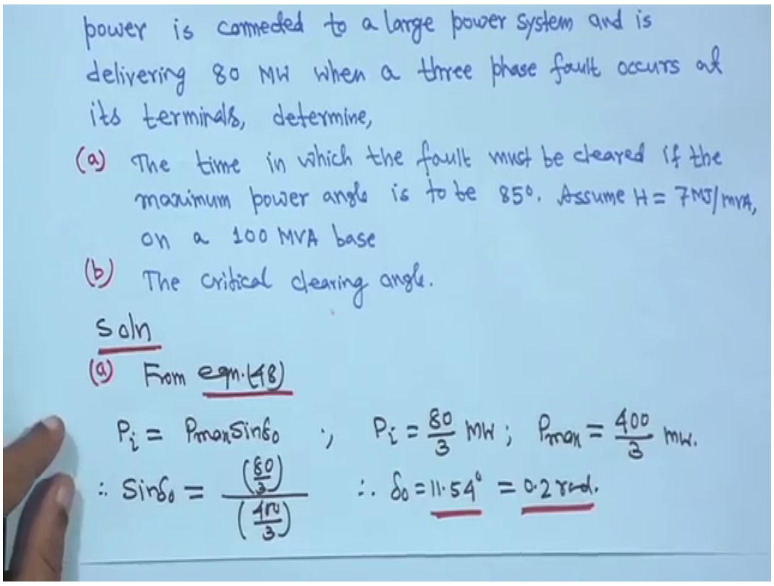

So, from equation 48 P i is equal to P m sin delta 0, you know this all equations are all equations already i have given, but let me search that where equation 48, otherwise you know this from the sin curve you know this it is equation 48 just hold on otherwise it not a problem you know everything. So, just hold on if i get it i will show you that P m is equal to this thing this here it is you know this that P i is equal to P max sin delta 0. This is equation 48. So, in that case it is 3 phase. So, P i will be 80 by 3 megawatt and P max will be 400 by 3 megawatt and then sin delta 0, we can find out 80 by 3 divided by 400 by 3. So, you will get delta 0 is equal to 11.54 degree or 0.2 radiant now it is given that maximum power angle is to be 85 degree this is given.

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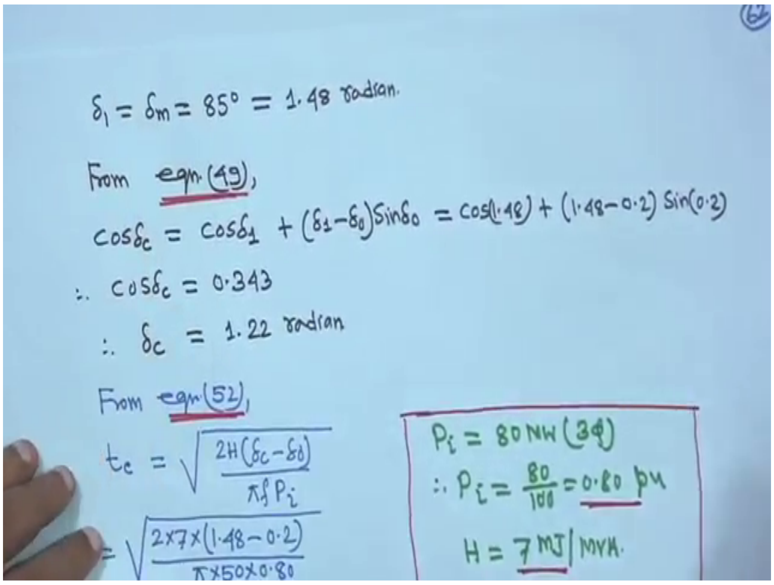

So, if it is given so; that means, delta one is equal to delta m is 85 degree that is 1.48 radian therefore, from equation 49; that means, this equation; this is your equation 49 that cosine delta c is equal to cosine delta 1 plus delta 1 minus delta 0, but delta one is equal to delta m is equal to 85 degree is equal to is equal to 1.48 radian; that means, you can write cosine delta c is equal to same formula I am rewriting here. So, everything put in radian. So, it is cosine 1.48 in bracket it is delta 1 minus delta 0 this is also radian 1.48 minus 0.2 the sin 0.2 this is all radian; that means, delta c you will get 1.22 radian that is your delta C and from equation 52 that your critical your what you call that clearing time expression. So, this is your 51, thus let me see if I find it that your 53 here; this is equation 52 that t c expression is given this is equation 52 and from equation 52 t c is equal to same equation we are rewriting and you put all the values you put all the values H value delta c minus delta 0 up on pi f P i. So, H is given 7.

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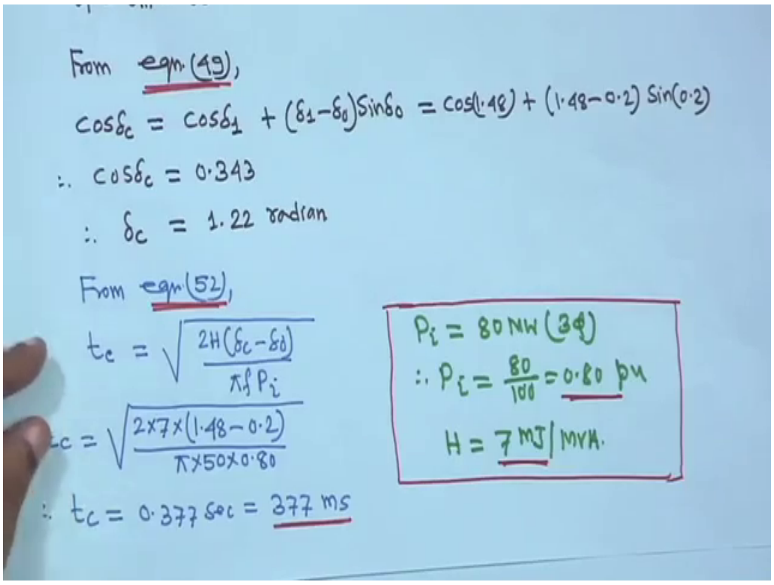

So, 2 into 7 delta c you have computed right you are here, I think while writing, I have made it type of graph I mean writing error, I think it will be your just hold on that where is that formula it will be delta c minus delta 0.

So, it will be your this delta C actually it is 1.22. So, I have made by mistake 1.48, I have taken this value by mistake delta 1 right, it will be actually 1.22 I think answer is correct. So, t c is equal to 0.377 second or 377; 77 millisecond, but I will request you, I do not have calculator here now, right, whether I computed it using 1.48 or 1.22, but correct is 1.22 I correct it, but if answer is little different, you please check with that calculator this is my request to you I do not have calculator here. So, this is your t c is equal to it may be 3 7 millisecond or if it is based on 1.48, then this answer will come, but this is not correct answer. So, basically it will be 1.22 I have now corrected. So, please make it otherwise this is the answer and right.

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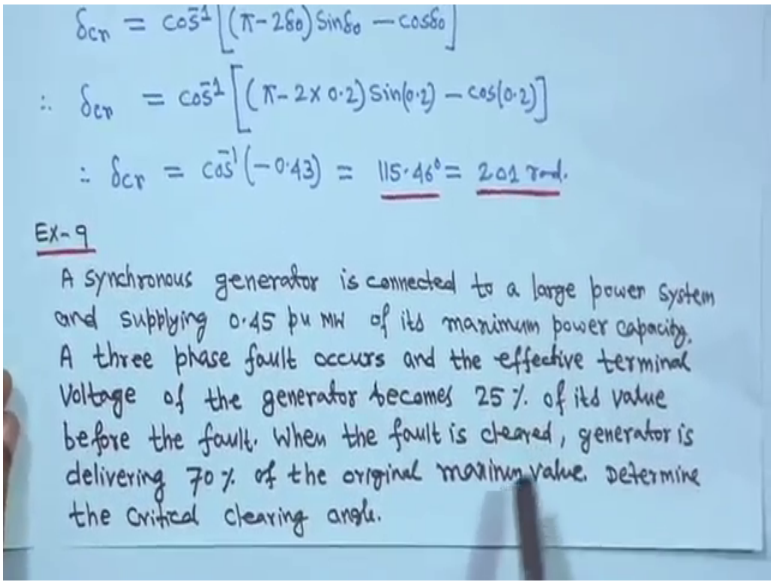

So, and from equation 53; equation 53, this one then your you will get that equation 53 cosine delta c r was given is equal to pi minus 2 delta 0 sin delta 0 minus cos delta 0. So, delta c r actually cos inverse of the all this thing you substitute all this values here all this values here you will get critical clearing angle will be 115.4 6 degree or 2.01 radian.

So, next is your example 9, next one is suppose a synchronous generator is connected to a large power system and supplying 0 0.45 per unit megawatt power of its maximum power capacity a 3 phase fault occurs and the effective terminal voltage of the generator becomes 25 percent of its value before the fault, but when the fault is cleared generator is delivering seventy percent of the original maximum value determine the critical clearing angle you have to find out the critical clearing angle so whatever.

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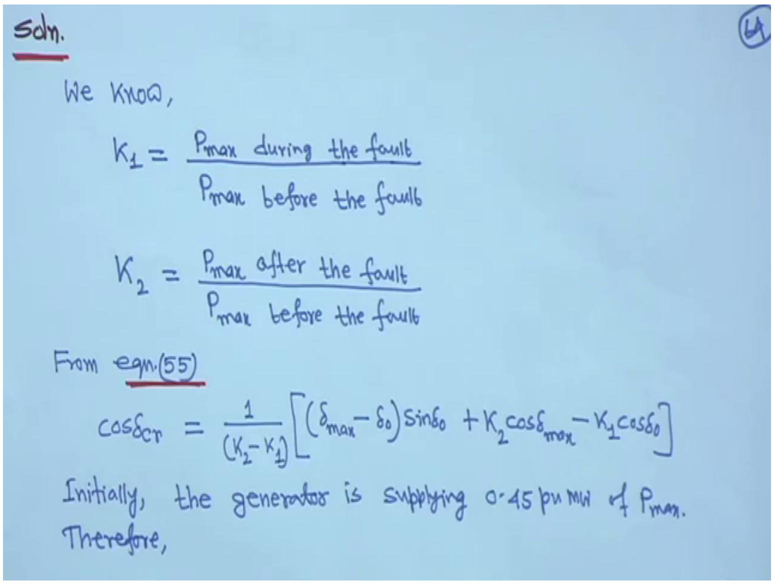

We have taken before actually K 1 and K 2; we have seen that K 1 actually P max during the fault and ratio of P max before the fault because we have taken your curve a, b and c curve b, we have taken it is K 1 into your P max sin delta. So, K 1 actually P max during the fault for the ratio whatever the during the fault what is the maximum value of the power P max divided by before the fault P max before the fault that is K 1 and K 2 is equal to P max after the fault and P max before the fault if I get it here; if I let me find it out if it is here I will; I can show you, but I have already told you all this things just hold on if I get it here then it is otherwise you know this here that a is equal to this is your before fault and this one that b is equal to it is your during fault and c is equal to this is after fault. So, therefore, K 1; K 1 will be whatever that this thing will come your P max during the fault and divide I mean denominator always is P max before the fault and K 1 is equal to P max during the fault and K 2 divided by P max before the fault this ratio.

And K 2 is the ratio of P max after the fault divided by P max before the fault from here only everything is given here only, therefore, from equation 55; this is the equation 55, we are rewriting, we are rewriting the whole equation here. So, initially the generator is supplying 0.45 per unit megawatt of P max. So, initially it was supplying; that means, ; that means, your this is actually P i as initially it was supplying your 0.45 per unit megawatt of P max; that means, this is actually your P i actually 0.45 P max is equal to you can write P max sin delta 0.

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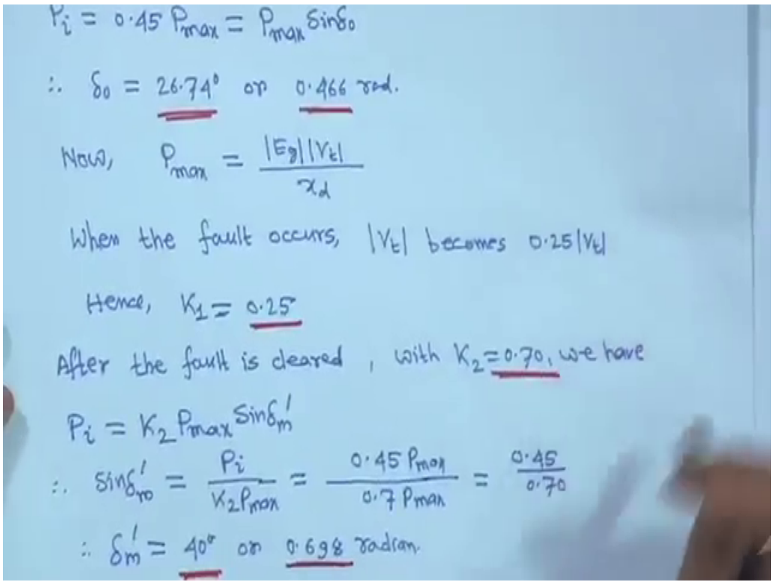

So, this is your we can write at operating point your at a operating point anywhere you take that is your this thing for example, any operating point here this delta 0 right. So, your P i is equal to 0.45 your P max is equal to P max sin delta 0 P max P max will be cancel. So, delta 0 will become 26.74 degree; R 0.466 radian. Now P max is equal to P max is equal to magnitude e g into V t up on x d now when the fault occurs when the it gives; it is given in the problem when the fault occurs the V t becomes 0.25 V t right. So, in that case in that case your K 1 will be 0.25 because everything will remain same only this 0.25 will be there so; that means, power will from its original value it will come down to 25 percent actually.

That is why K 1 will be 0.25, now after the fault; is cleared K 2 will be 0.70 because that is also given in the problem that is also that is also given in the problem that it your that when the fault is cleared generator is delivering 70 percent of the original maximum value. So, determine the critical clearing angle I mean if you look at the graph initially it was P max, but during the fault it was actually 0.25 P max and when fault is cleared.

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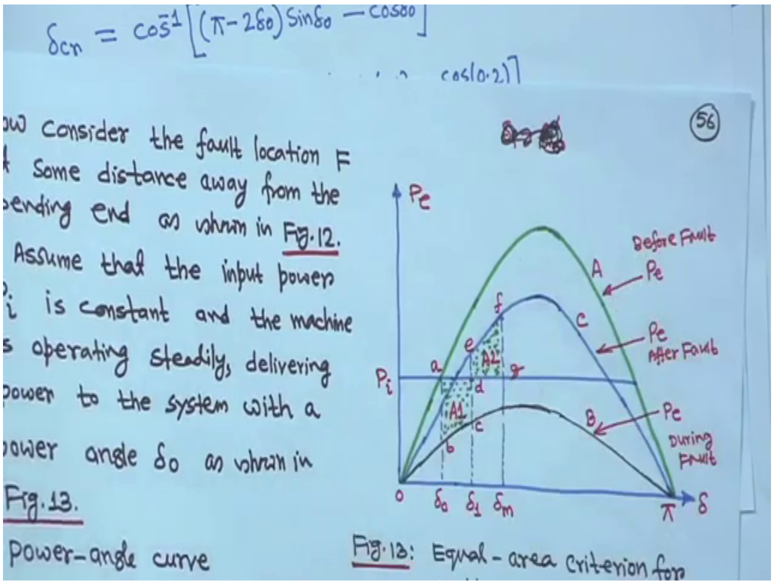

It is actually 0.7 P max right. So, this is the philosophy. So, from this graph you can make out this is P max, this is 0.25 P max and this is 0.7 P max; this blue one and black one is 0.25 P max and this is P max sin delta. So, if you take all this data that then K 1 is known K 2 also then known it is 0.7. So, therefore, P i is equal to K 2 P max sin delta m dash just hold on I have to take that graph again. So, the here it is. So, this is actually this is this blue curve you take blue curve this blue one that it and this blue horizontal line that P i line and this is delta m dash this is delta m dash therefore, after the fault is cleared.

So, this is the blue line it is operating in operation this is that this is the power that supplied by your what you call from the generator P e P max is equal sin delta your into your whatever fraction is come 0.7. So, this is that graph. So, and its and it whereas, blue line the intersection is delta m dash. So, that is why after the fault is cleared K 2 is 0.7 and we have P i is equal to K 2 P max sin delta m.

So, this is your graph C actually, this is your graph C. This is your graph C and here it is C is equal to K 2 a K 2 P max sin delta K 2 is equal to 0.7, then this one P i is equal to K 2 P max sin delta m dash so; that means, this point delta m dash means this point this point. So, in that case you compute what is your delta your m dash. So, P i it, we can write sin delta m dash is equal to P i upon K 2 P max. So, P i is your sin delta is equal to 0.45 P max divided by 0.7 P max. So, that is actually coming 0.45 by 0.7. So, in that case you will get delta m dash is equal to your 40 degree because P i is equal to 0.45 P max, it was given that 45 percent of that. So, P i is equal to 0.45 P max. So, here we have put P i is equal to 0.45 P max divided by 0.7 P max is equal to 0.45 by 0.7, this actually comes to delta m dash is equal to 40 degree or 0.698 radian right so; that means, delta max; that means, your; this is your delta max. So, delta max is equal to pi minus delta m dash.

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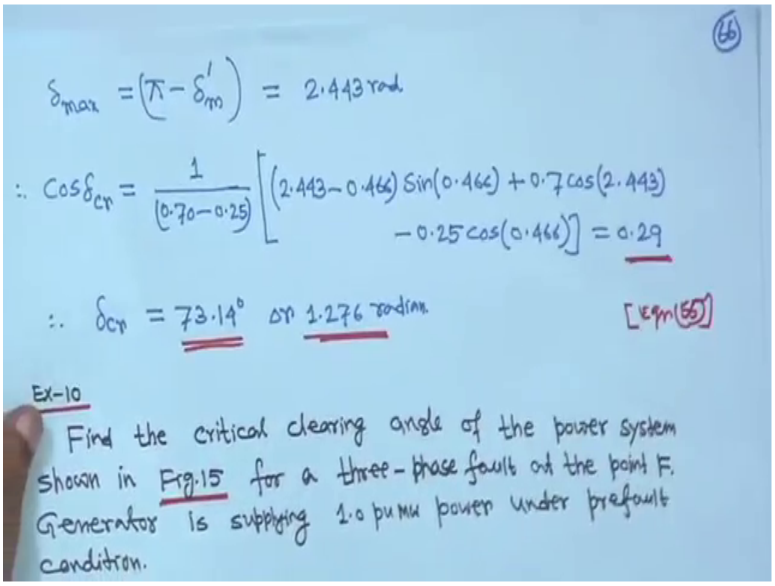

The delta max is equal to; that means; from here that delta max is equal to pi minus delta m dash. So, delta m dash we have computed 0.698 radian this you have computed here we have computed.

So, if you put it here it will be 2.443 radian and in the all this data available now go back to equation 55. I have not read it and that equation again, but it is equation 55 cosine delta c r due is equal to one up on K 2 minus your K 1 then 22.443 that is delta max, right your minus 0.466 that is delta 0 that is sin of it is radian 0.466 plus your 0.7 cosine 2.443 that is K 2 cosine 2.443 and minus 0.25 that is K 1 cosine 0.466 that is delta 0 and if you compute all it will become is equal to 0.29; that means, delta critical angle will become 73.14 degree or 1.276 radian, right, directly you can put it there and you will get this answer. So, this is the answer now another one; this is this one among all this one is the easiest one, but only you need delta star star delta transformation now I will show you the figure, now I hope this you have understood, right that how to find out at your critical clearing angle or critical clearing time now this is another example it is a double circuit line. So, find the critical clearing angle of the power system shown in figure 15, I will give you for a 3 phase fault on the point f, I will show you the diagram. So, generator is supplying initially one per unit megawatt power initially power it was supplying one per unit megawatt power under pre fault condition that is before fault before fault it was one.

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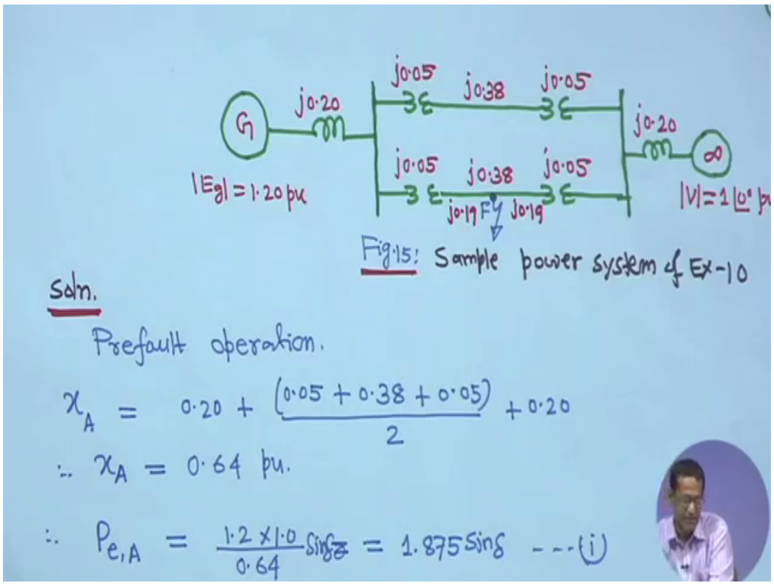

Now this is the circuit connection this generator right reactance is given 0.20, here transformer is there 0.05 all j are there not uttering again and again.

This is line reactance 0.38, again transformer 0.05; this is also 0.05 line 0.3; 0.05, 0.20. So, before fault line; impedance was reactance was 0.3, but fault has occurred 3 phase fault is the middle of the line that is why here also I have seen this side it should be half this side it should be half. So, no confusion and total is in this line there is a fault and this side is j 0.19 this side is j 0.19, but total when there is no fault 0.38 and identical identical parameters and this side voltage generator voltage is one 0.20 per unit and this is infinite bus right. So, it is magnitude is one angle 0 per unit. So, now, pre fault condition when there is no fault. So, dont consider you put your finger here no no fault it is there so; that means, 0.2 should be added j i am not putting again and again it is reactance calculation that is your pre fault operation that is a; that means, curve a when the when look at this when when when when you are making a b c you know you have to imagine in this way that this is pre fault graph a when i will make x b it will be during fault and when i will make c it will be after fault. So, a b c this way we will do it then we will not make any mistake. So, in this case this is your double circuit. So, this 2 line are in parallel. So, there is no fault; that means, equal equal it is 0.38 plus 0.1 0.05 0.1. So, 0.48 and 0.48 this 2 are in parallel. So, it will be 0.224 and this side 0.2 this side 0.2. So, 0.4 plus 0.24 it will become 0.64 per unit.

So, this pre fault condition this is pre fault or operation that x a will be 0.2 plus it is parallel equal. So, it will be taken half 0.05 plus 0.3 plus 0.05 by 2 plus this 1.2. So, it is coming x a is equal to 0.64 and the graph a is that your pre fault condition and voltage is given 1.2 and one throughout this 2 voltage will not change. So, it will be 1.2 into one divided by x a. So, 0.64 sin delta is equal to it will become 1.87; sin delta; that means, it will be your this graph green color graph a that is why I am making it P e a graph A; that means, this will be your graph a similarly now during fault before that you have to compute also this delta 0 angle on the green curve this delta 0 angle is also require right your P i is given 1 P i is given one per unit this is given. So, in that case in that case that delta 0 will be sin inverse one up on 8 point.

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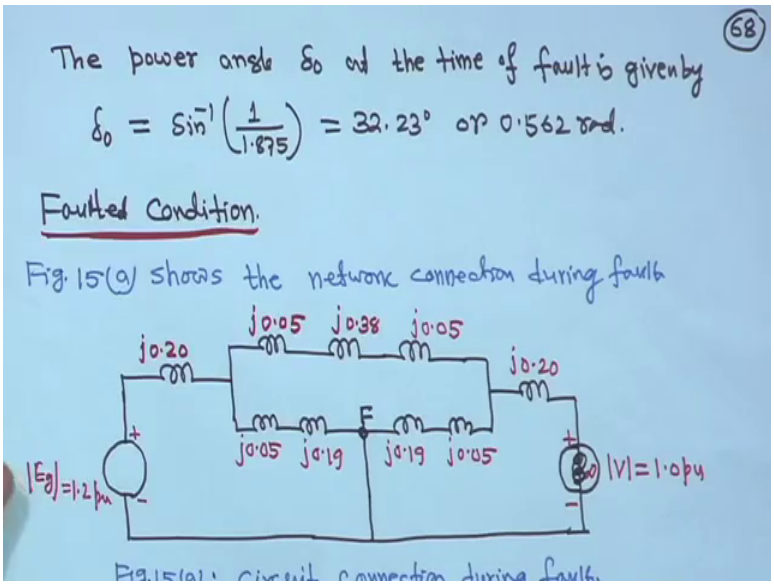

Your 7 5 because when P e is equal a is equal to P i operating at steady state right before fault. So, it will that is 1 is equal to one is given P i is equal to that is 1.875 sin delta the delta is equal to your sin inverse that is delta is equal to delta 0 at this point delta is equal to delta 0 at this point delta is equal to delta 0 so; that means, you will get delta 0 is equal to sin inverse one up on 8 point 1.875 that is coming 32.23 degree or 0.562 radian.

So, next is during fault. So, suppose fault has occurred at this middle of the line second line here. So, this side should be 0.19 this side should be 0.19. So, if it is shown, then you draw this diagram fault has occurred at the middle of the line, this is 0.2 of this line will remain same. This line will remain same. So, j 0.05, j 0.38, j 0.05, this is j 0.05 that will be half half j 0.19, j 0.19 then 0.05.

This is 0.2, this is generator side this is infinite bus side actually this is infinite bus side somehow I have made this thing, I have removed this, but this is infinite bus and this is your circuit connection during fault right. So, this way you should know fault has occurred in the middle of the line. So, once you make this connection well look at that this is basically delta connection you have to convert it to star. So, delta star connection you can make it of your own I can give you the your final value right this is basically your just hold on this is basically your del delta delta connection I mean I just write for you only this part this part is a this is at delta connection suppose this is your fault this is fault position as a this is your f say am just putting it like this.

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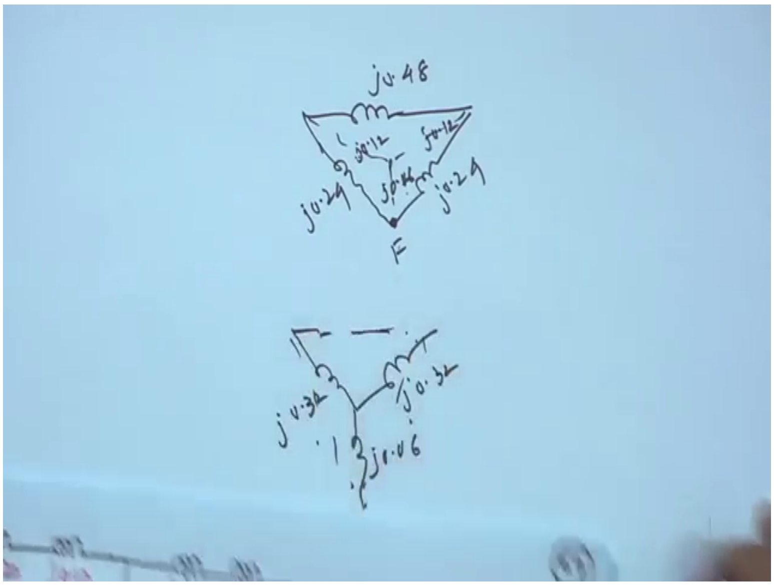

So, this 2 are there 0.05 and 0.19. So, this should be your j 0.2;4 this side also 0.19, 0.05 this is also j 0.24 and this is 0.35, 0.05, 0.05. So, 0.48.

So, this side will be your j 0.48 and if you if convert it to star you convert it to star if you convert it to star this side it will become your j 0.12 this is j 0.12 and this will become j 0 0.06, we just delta to star you know how to convert it you convert it. So, if you convert it then connection will be this side will be point j 0.12 this side will be 0.12 and to the; from here to the fault point j 0 point j that point f to 0.06.

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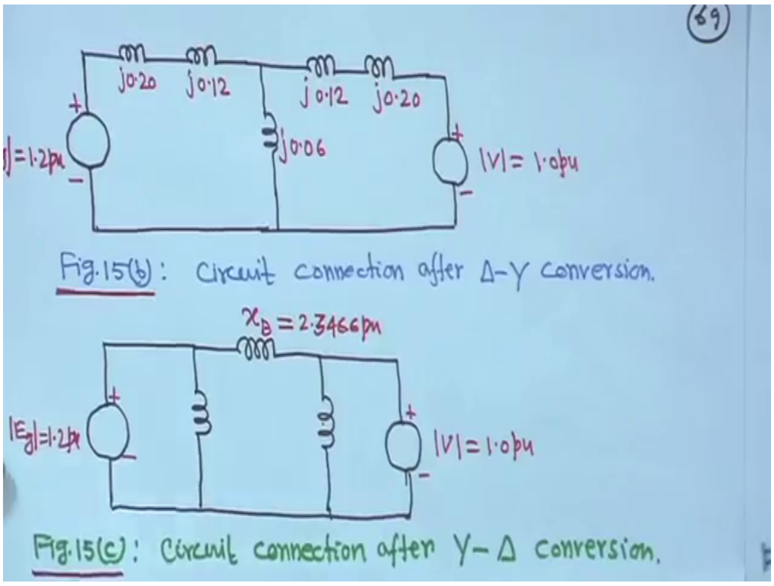

So; that means, this one it is with that this side it was j 0.20 this side also j 0.20 so; that means, this 2 will be in series. So, j 0.2 j 0.12 this side j 0.12 j 0 point. This is j 0.06. So, this is the delta star conversion. Now if you make this one this is now star connection because this is this side will be 0.32, this side will be 0.32 and this will be point and this one will be point 0 j 0.06. So, this is now star connection this one again we have to converse star has to be converted to that delta. So, right if you converse star to the delta this 2, I have not computed no need because here you generator is there here this side is infinite bus is there for power times for we need only the x b.

That is during fault this one is required this 2 are not required actually. So, this 2 I have not computed. So, this is a star connection I am showing you, but you will do it I am showing you. So, this is your star connection this is your star connection this side will be j 0 0.32 this side I actually I have made it for you this side 0 point 0 and this is your j 0 0.06 and this is your convert it convert it to delta convert it to delta this 2 side not required only this one is required right. So, if we if you converse star to delta only only that side that x b.

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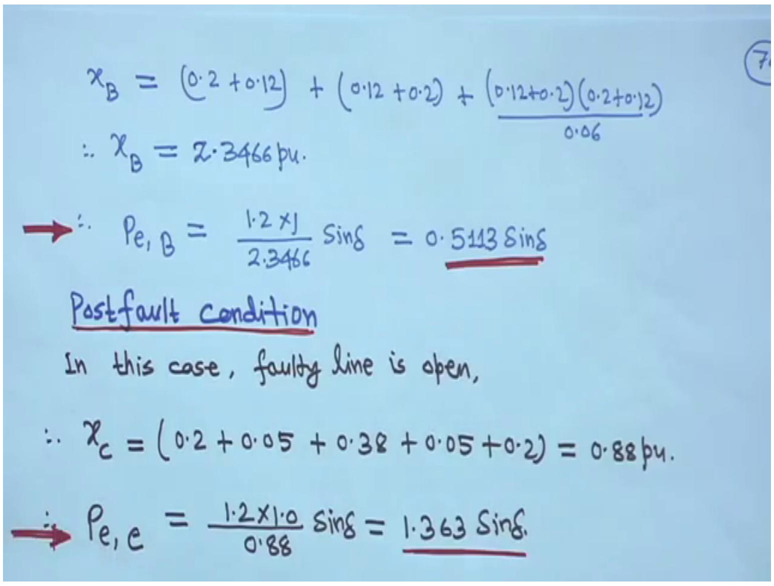

So, if you convert, then it will become that 0.2; 012. So, 0.2 point, it is actually the formula is suppose R 1, R 2, R 3 then R 1 suppose R 1 star R 1, R 2, R 3, suppose you want to convert it to delta star to delta it will be R 1 plus R 2 plus R 1 R 2 divided by R 3. So, same way you have made it suppose for example, this is your; this side is your x 1. So, 0.2 plus 0.12, this side is you say this side is your x 2. So, it is 0.12 plus 0.2; both are equal plus product of this 2 divided by your x 3 that is your 0.06. So, if you make x b it will be 2.3466 per unit this is your what you call that that delta conversion this value, but this is not require for power transformer transfer this is not require at all.

Because nothing easier actually voltage across this one voltage across this one. So, only this one is require. So, once it is done then and this voltage 1.2 and one always remain same; that means, your electrical power P e b that is during fault it will be 1.2 into 1 divided by 2 that is x b 2.3466 sin delta this will become 0.5113 sin delta; that means, this graph; that means, this graph this graph will be 0.5113; sin delta during fault this graph and now post fault condition when that when the fault is cleared when fault is cleared when this fault is cleared. This line is isolated this line is isolated only this line will be there this fault is cleared, then you have to find out that what is the value of x c because we have to find out P e for curve c. So, this line is isolated when the fault is clear. So, in this case fault line is open. So, this line is not there it is open, right. So, this line is gone only this line is there. So, in that case in that case just you add all the all the all the reactances; this one, this one, this one, this one, and this one just add because this line is open, right. So, in that case that faulty line is open. So, x c is equal to 0.2 plus 0.05 plus 0.3 plus 0.05 plus 0.2 is equal to 0.8 per unit.

That means for curve c for this one that is after fault this curve for curve c. So, this is x c and P e c is equal to 1.2 into 1.0 up on 0.88 sin delta is equal to 1.363 sin delta; that means, this graph the graph c is 1.363 sin delta right with getting all this thing. So, all the all the 3 graphs; we have got I mean power delivered during your pre fault during fault and post fault all you have got therefore, K 1 will be K 1 will be we have told you that it will be P max during fault.

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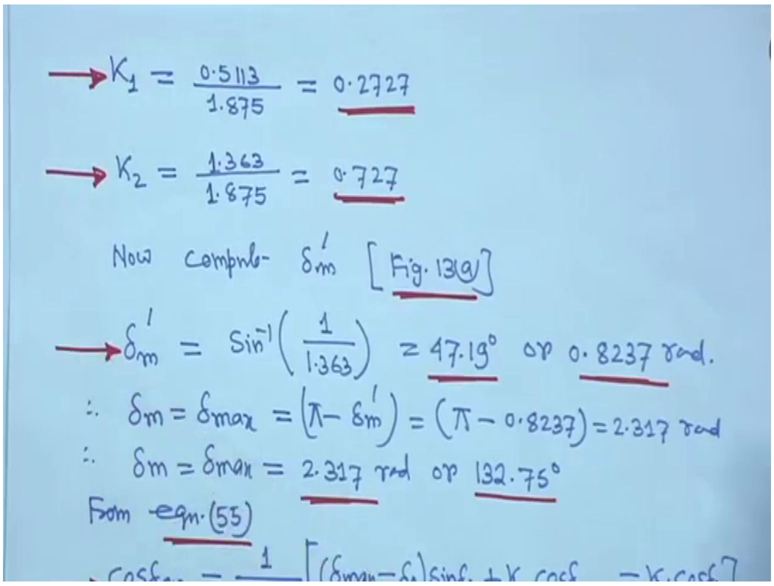

that is 0.5113 this one let me see I have to search it this is 0.5113 and this is we have got it that before fault 1.8 pre fault condition 1.875 that is 0.2727 K 2 is equal to your when your; after fault that is your 1.363; just now we have got graph C 1.363 divided by that your pre fault condition max 1.875. So, 0.727. Now you have to compute delta m dash. So, delta m dash actually this one this is your delta m dash that is the blue curve that is the blue curve right this is your delta m dash and in this is the intersection of this horizontal line and this blue one this is your delta m dash. So, in that case that your delta m dash will be because we have seen that c curve it is 1.363 when delta is equal to your delta m dash that is 1.363 sin delta m dash.

So, at that time this power this is given P i is 1, this P i is 1 and when P i is 1 and delta m is equal to delta m dash. So, this graph will put that. So, in that case your delta m dash will be sin inverse one up on 1.363. So, that will come 47.19 degree or 0.8237 radian. Now delta m is equal to delta max is equal to pi minus delta m dash; that means, this one delta max is equal to pi minus delta m dash this one. So, we get delta max is equal to this 12.317 radian; that means, delta m is equal to delta max is equal to 2.317 radian or 132.75 degree once you got all this then equation 55 from equation 55 rewrite.

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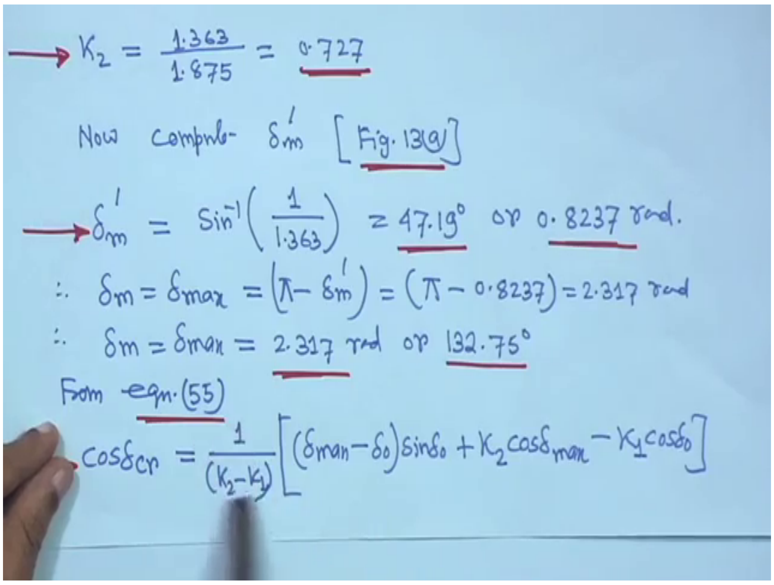

This equation this equation has been rewritten now put K 1 value K 2 value delta max value delta 0 value you will get the delta c r once you put it once you put it.

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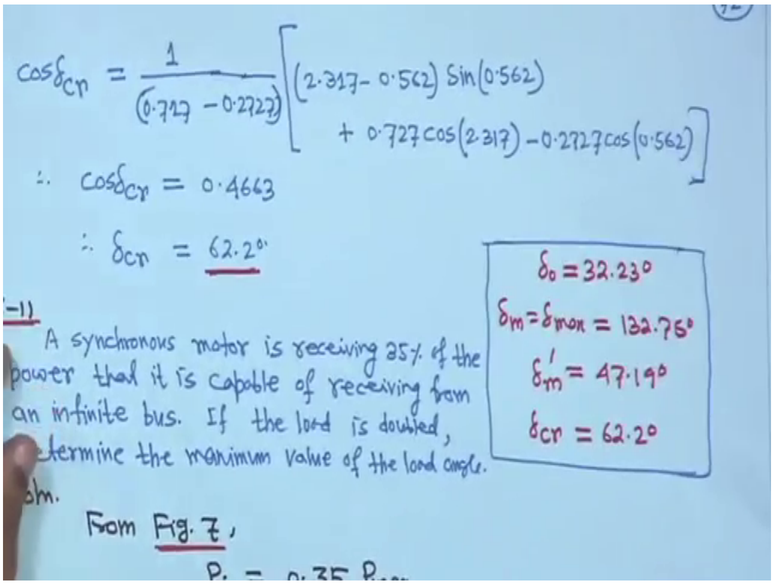

Then this one you substitute all this value all are radian you have substituted all this is radian; that means, cosine delta c r will be become 0.46363; that means, delta c r will be 62.2 degree. So, results are summarized here for this problem results are here results are summarized that delta 0, we got 32.23 degree delta m dash we got 47.19 degree delta c r we got 62.2 degree and delta m is equal to delta max we got 132.7 degree.

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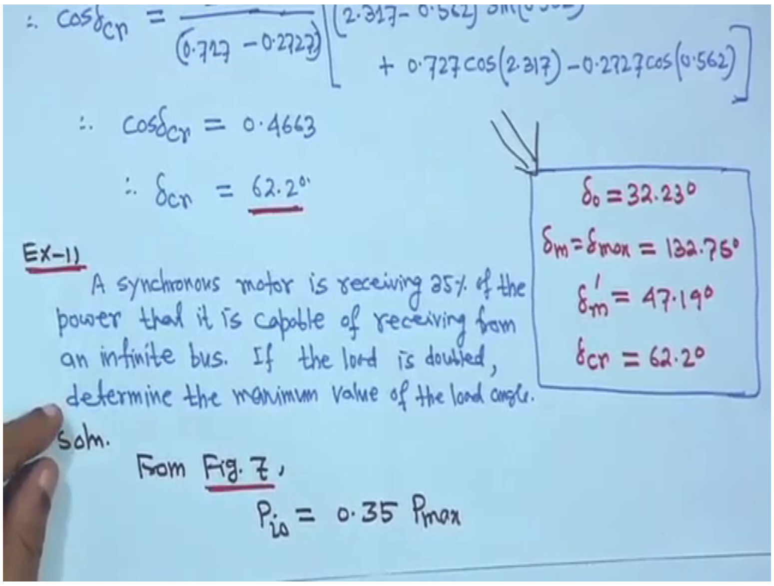

So, this is one and another one another example you take this is a this is a short example I mean small example suppose a synchronous motor is receiving 35 percent of the power that it is capable of receiving from an infinite bus if the load is doubled determine the maximum value of the load angle right. So, it is said that it is given that synchronous motor receiving 35 percent of the power that is capable of receiving from infinite bus, but if the load is doubled determine the maximum value of the load angle. So, from figure 7; figure 7, if you go back then I think I have figure 7 in front of me.

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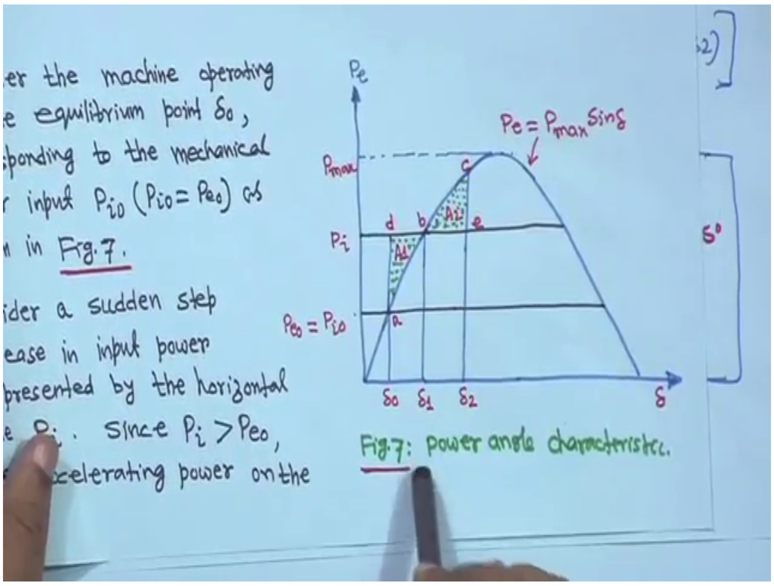

This is my figure 7. So, it is P e 0 is equal to P i 0 and this is P max sin delta this is figure 7 from figure 7. So, P i 0 is equal to it is given 35 percent of the power. So, P i 0 is equal to 0.3 P i 0 is equal to 0.35 P max this is P max this is P max.

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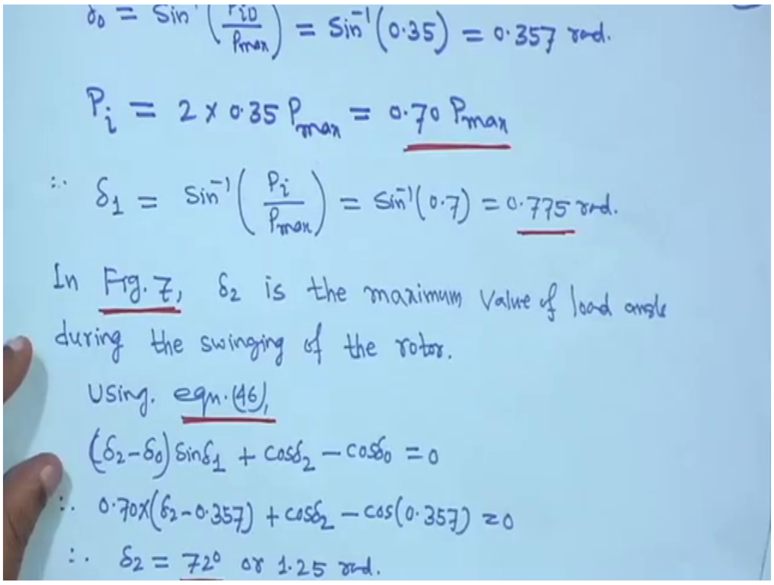

So, P i 0 is equal to 0.35 P max therefore, you that is delta 0 delta 0 is equal to sin inverse P i 0 up on P max that is sin inverse 0.35 is equal to 0.35 7 radian and now it has been doubled. So, P i you will be is equal to 2 into 0.35 P max because it has given if the load is doubled now, right. So, determine the maximum value of the load angle now it is doubled. So, it is P i is equal to 2 into 0.35 P max that is 0.7 P max therefore, you have to you have to compute delta 1 that is your delta 1.

So, that is delta 1 is equal to sin inverse P i up on P max that is sin in bus 0.7 it will become 0.775 radian. Now in figure 7 delta 2 is the maximum load angle during the swinging of the rotor. So, in this is figure 7, this is the delta 2 is the maximum rotor angle, right. So, using equation 46, you have rewriting equation 46; here the delta 2 minus delta 0 then sin delta 1 plus cosine delta 2 minus cos delta 0 only here delta 2 is unknown. So, put all these value delta 2 your this thing sin delta one right. So, put all these value here. So, delta first I am writing this delta 2 minus delta 0 is 0.35 7 then sin delta one that is by your coming 0.7 your 7 and then your; here it is given that delta one is equal to sin inverse 0.7; that means, sin delta 1 is equal to 0.7. So, we have putting here sin delta 0.7 no confusion plus cosine delta 2 unknown minus cos delta 0 delta 0 is equal to 0.35 7 radian.

So, cosine 0.3 is equal to 0; that means, delta 2 maximum you are getting 72 degree or one 0.25 radian. So, this is that last example of this power system thing stability and finally, this; what is the conclusion. So, I have written something here.

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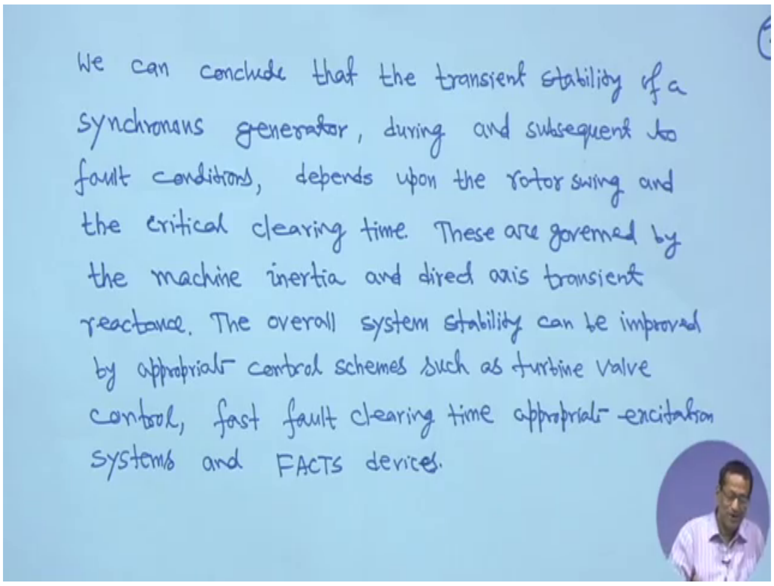

That we can conclude that the transient stability of a synchronous generator during and subsequent to fault conditions depends up on the rotor swing and the critical clearing time these are governed by the machine inertia and direct axis transient reactance, the overall system stability can be improved by appropriate control schemes such as turbine valve control fast fault clearing time appropriate your appropriate excitation systems and facts devices that is flexible transmissions devices right, but those are the thing that you can be improved.

Now, for power system stability studies whatever your; we have studied I mean little bit of steady state stability and that is basically that gradual increase of the load that is maximum your loading capability before losing synchronism then little bit we have tried to understand regarding dynamic or small signal stability that is due to small system disturbances and finally, transient stability for single machine infinite bus system that is for your; for large disturbances and we have also defined in this topic that what is infinite bus and we have tried to obtain that your critical clearing time.

So, with this those will be listening this last class one or 2 line that one or 2 few 2 things before closing this courses because this is the last one that starting from the beginning that structural power system and various aspects of power system and there are and you have come to this transient your first system stability and within the within the given your time frame that we have tried to cover I think 9 or 10 chapters although there are many other chapters in power systems and whatever we have tried that all the all the your theories particular for classroom exercise that. So, many all the theory or theories are mathematical derivations all supported by good number of examples

And particularly for when you come to the iterative techniques that is load flows or the little bit of optimal system operation that is economic load dispatch we know that in the classroom or in the exam hall that it take it is time consuming without computer, but at least one or 2 iterations you can try from your side quickly that what is the result. So, in that in this lecture also I have shown I think 2 or 3 iterations load flow also Newton Raphson load flow also only couple of iterations and optimal economic load disperse also I have shown the step.

But that is basically coding is required not this thing, but we have tried to explain that this way this are way one can do it, but as far as classroom exam is concerned or your classroom exercise is concerned that you should make one or 2 iterations that and make every step is correct. So, with this your feedback will be more important for me and what I would like to tell that if you find any mistake or any error particularly that calculations. So, that it was all this numerical actually have been done by me I mean before coming to this lecture also that your delta star star delta transformation may be through 2 2 2 2 and half hours back I was calculating by calculator that whether everything is correct or not.

So, if I make any mistake or any error is there in calculation please mail me such that I can correct those numerical and whenever any writing is error or anything I have mistake that you please see only for 3 phase fault cases only my emphasis was to for z bus building algorithm and other thing little bit of Thevenin equivalent this that I pre assume that this are simple thing you know it with this I have to tell you that.

Thank you.