Circuit Theory

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Lecture 33

Solutions of Minor-2

Problems and More on Scattering Matrix

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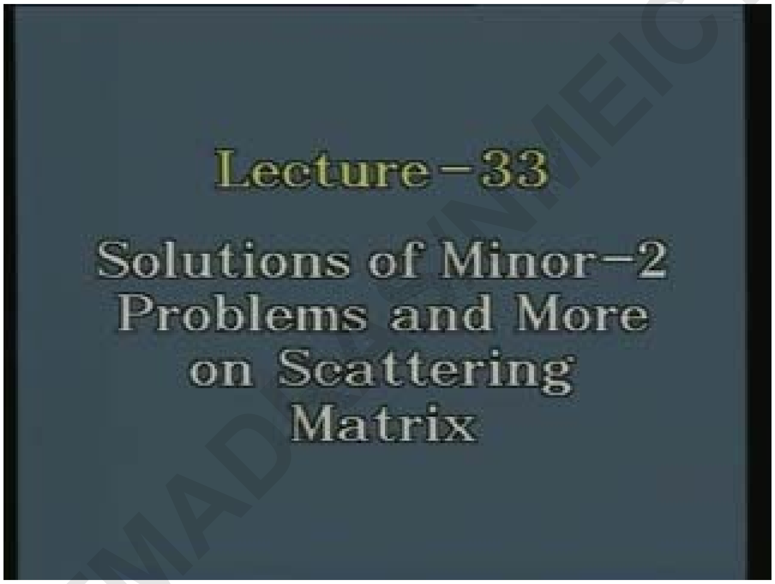

thirty third lecture three three and [Vocalised Noise] what we are going to do is to solve the minor two examination problems point out the difficulties that you experienced and the common mistakes that you that you made and if time permits as i hope it will we shall do little bit more on the scattering matrix of a two port

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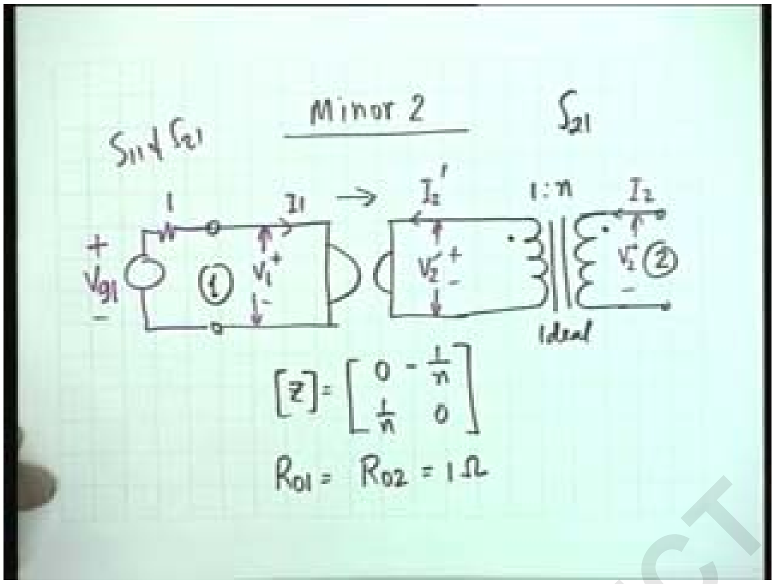

minor two the first problem [Vocalised Noise] the first problem was with regard to a gyrator [Vocalised Noise] this is the forward direction [Vocalised Noise] and the gyration constant is not given what is given is that the Z matrix of this is given as zero one by n minus one by n one by n zero this is the Z matrix that is given and then it is cascaded to a transformer ideal transformer one is to n this is ideal

this is port two and this is port one and what is needed is [Vocalised Noise] scattering parameters that is you have to find out S one one S one two S two one and S two two with the reference registers at both ports equal to one ohm this was the question alright now some of you [Vocalised Noise] some of you tried to ah [Vocalised Noise] solve it by finding out the abcd parameters abcd parameters of the two networks multiplying them out and then from the abcd parameters go back to the voltage current equation and then find out S one one S two two and so on and so forth

in the process one of the mistakes that you did was that you assumed ab minus bc for this is equal to one which is not correct i used formulas which are true for reciprocal networks only in fact [Vocalised Noise] some of you calculated S two one and said because this is reciprocal this must be equal to S one two equal to one which is not correct the non reciprocity is obvious here the gyrator is a nonreciprocal network and therefore you cannot do that one of the other mistakes that happened was with regard to the transformer equation you see the side that has n the turns ratio it is from this side that the impedance is n squared times the impedance here not from this side and the voltage current equation many of you could not write correctly that is a pity is a open book open notes examination and you must be able to write the voltage current equation

now the simplest way that i find of doing this is to assume the voltages and current do not make any conversion just find out just write down the voltages and currents at various points and you will see how easy it becomes this is V one [Vocalised Noise] this is I one i suggest that you take this down this is let's call this V two prime I two prime these are all conventions then this is V two and this current is I two alright that's all that we need

now if you look at the gyrator if you look at the gyrator well what you have to do is to calculate S one one and S two one you have to terminate the port one into a one ohm resistor in series with a Vg one a voltage a voltage source Vg one alright

[Vocalised Noise] and

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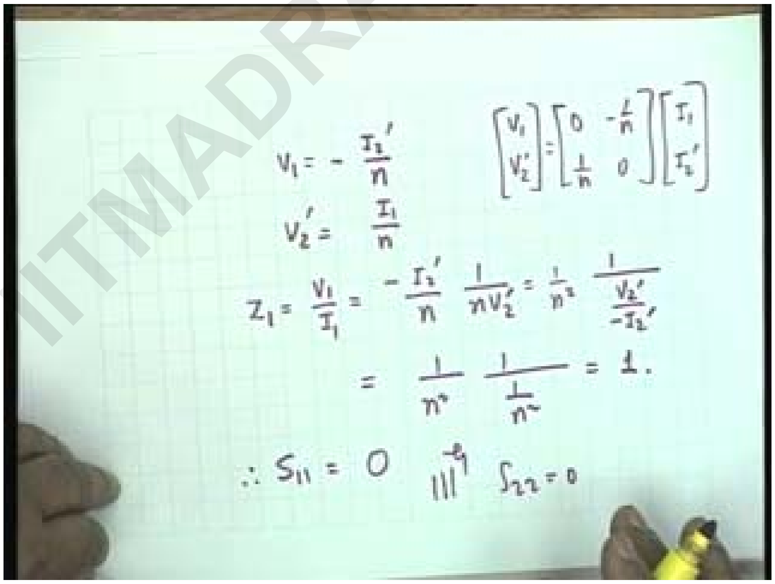

ah if i look at the gyrator then obviously V one V one you see the the equation [Vocalised Noise] is V one V two prime the Z matrix is given zero minus one by n one by n zero times I one I two prime this is the this is the Z matrix equation V one V two prime these are the two voltages and these are the two currents therefore V one as you can see is equal to minus I two prime by n and then V two prime is equal to V two prime is equal to I one by n that's all

so let's find out the input impedance of at port one that is Z one which is equal to V one by I one V one by I one now let's substitute for V one minus I two prime by n multiplied by I one is n times V two so n times V two that is equal to one by n squared and i can write this as V two by minus I two alright now V two by no prime V two prime by minus I two prime i missed the prime

now if you look at the network V two prime by minus I two prime is the impedance looking here and since you have to terminate this into a one ohm resistor [Vocalised Noise] one ohm resistor the impedance looking here would be

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one by n squared not n [Vocalised Noise] squared one by n squared alright and therefore i can write this as one by n squared multiplied by one by squared which is simply equal to one the input impedance is one [Vocalised Noise] and therefore S one one is equal to Z one minus R zero one divided Z one plus R zero one that is equal to zero okay and in an exactly similar manner [Vocalised Noise]

if you go back that is terminate this in one ohm [Vocalised Noise] and find out the impedance here ((if)) (00:06:41) that will also be exactly one ohm and [Vocalised Noise] therefore S two two S two two is also equal to zero the procedure is exactly similarly let's calculate S two one and S one two for S two one

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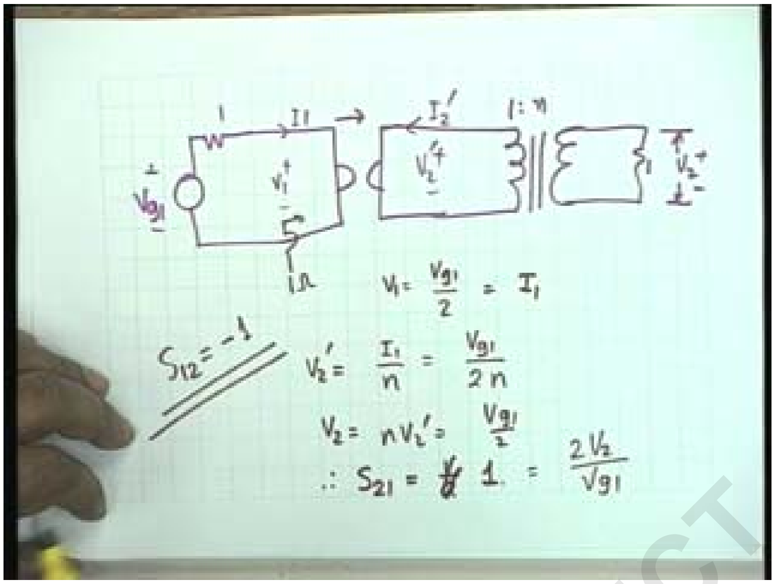

let’s go back one ohm Vg one then you have the gyrator and the ideal transformer one is to n this is one ohm this is what you have to calculate V two okay [Vocalised Noise] and to do that this is V one I one again V two prime I two prime

now since this impedance looking here is one ohm obviously these are simplifying things things are it should be V one should be equal to Vg one by two and V one is the voltage dropped across a one ohm resistor by the flow of a current I one I one flows I one sees a resistance of one ohm and therefore this must be equal to I one is that clear and once you pardon me is that okay

((you see)) (00:08:05) the impedance here is one ohm so V one is the drop in a one ohm resistor due to a current of I one and therefore V one is equal to I one multiplied by one and once you recognized this it will become very simple V two prime which is equal to I one by n from the Z matrix equation V two prime is I one by n therefore this is equal to Vg one by two n because I one is Vg one by two and V two is equal to V two this is the voltage that you have to find out that that should be equal to n times V two prime n times V two prime

so this is Vg one by two and therefore S two one is equal to twice V two by Vg one square root R one by R two R one and R two are the same therefore this is simply equal to half

<a_side> (( )) (00:09:06) <a_side>

i beg you a pardon this will be equal to one because S two one is twice V two by Vg one okay

[Vocalised Noise] now [Vocalised Noise] the the total device is non reciprocal and therefore if you found out many of you did if you found out by mistake due to change of sign of a particular current that S one two is equal to one you should have suspected your calculation right then and there will be good

S one one two cannot be equal to one because the gyrator is nonreciprocal and nonreciprocal device cascaded with a reciprocal device cannot make it [Vocalised Noise] {nonrecipro}(00:09:52) cannot make it reciprocal it is possible the other way round you may have combinations of nonreciprocal devices which make the total network [Vocalised Noise] reciprocal but not the other way round and therefore if you proceed in an exactly similar manner and take account of the directions of current correctly and the transformer equation correctly you should be able to obtain S one two equal to minus one that is the correct result that is question number one [Noise]

<a_side> (00:10:27) <a_side>

excuse me sir

yes

<a_side> ((for a reciprocal network is it necessary that S two one should be equal to minus S one)) (00:10:32) <a_side>

no for a reciprocal network

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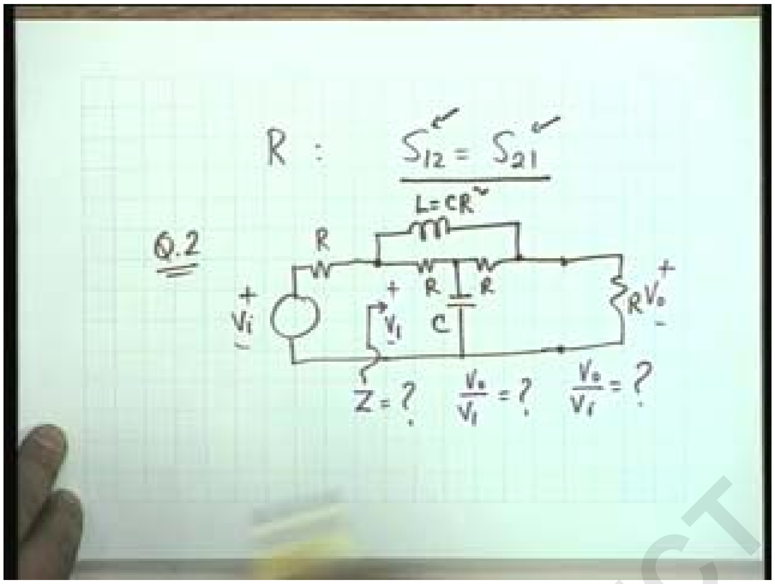

reciprocity demands that S one two is equal to S two one not a negative no for reciprocity S one two should be equal to S two for the definition of reciprocity because what you are doing is interchange the source and the load interchange the cause and excitation

reciprocity demands that this cross scattering parameters or the transmission parameters transmission scattering parameters let's say this is the forward transmission coefficient and this is the reverse transmission coefficient the two should be equal [Noise]

this device is nonreciprocal question number two is a network which is a parallel combination of two networks one is R R and C is terminated in the resistance of capital R and then there is an inductance here of L equal to CR square do not tell me i didn't do such a problem in the class [Noise]

in fact in fact what i did was a i took bridge to T the exactly the same except that there is a small resistance here this is a simpler one not only simpler from that consideration but it is also simpler because L is related to C and R square and even though [Vocalised Noise] there are two energy storing elements and inductance and the capacitance it behaves ((as a)) (00:12:16) first order network there are cancellations

now the [Vocalised Noise] question says question says find out this impedance Z then if this voltage is V one and this voltage is V zero you have to find out Z you have to find out V zero by V one and you have to find V zero by Vi these are the three things to be found out let me go systematically [Vocalised Noise] to solve the network well the the constraint was you cannot use mesh and node analysis some of you played a little smart i didn't penalize it to the extent that i should have done but some of you what they did is [Laughter] assume a current here take this to be I one take that to be I two alright then again another distribution here don't you see that this is in disguise a mesh analysis a combination of mesh and node analysis okay

you were asked not to resort to that alright [Vocalised Noise] those who have done so one or two one or two i didn't tell penalize if this is a general phenomenon then i will penalize penalize heavily but since there are only one or two and i was in a good mood that day [Laughter] i didn't penalize greatly okay

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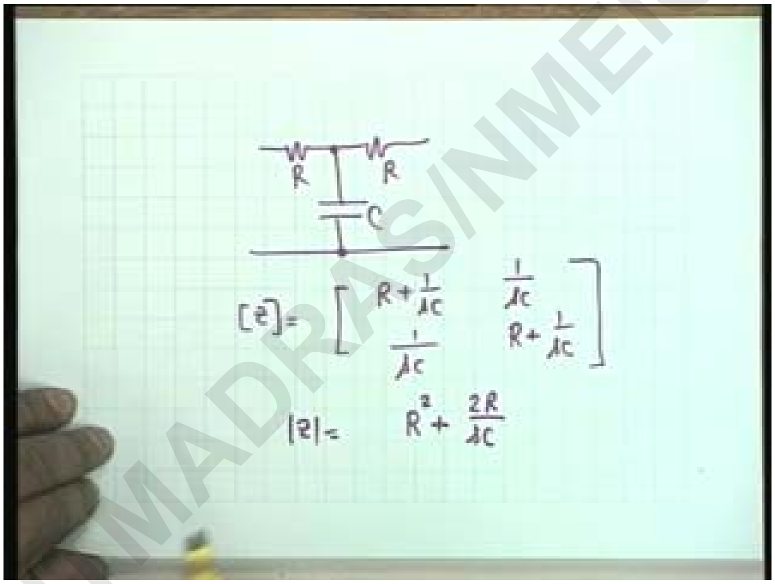

so the first thing we do is we find out the y parameters of this okay the Z matrix can be written down by inspection R plus one over sc i did this in the class one over sc one over sc R plus one over sc and the determinant of Z is equal to [Vocalised Noise] R squared plus twice R divided by sc which i can well let me leave it like this unnecessary simplifications i will not do till the last moment okay and [Noise]so the y parameters

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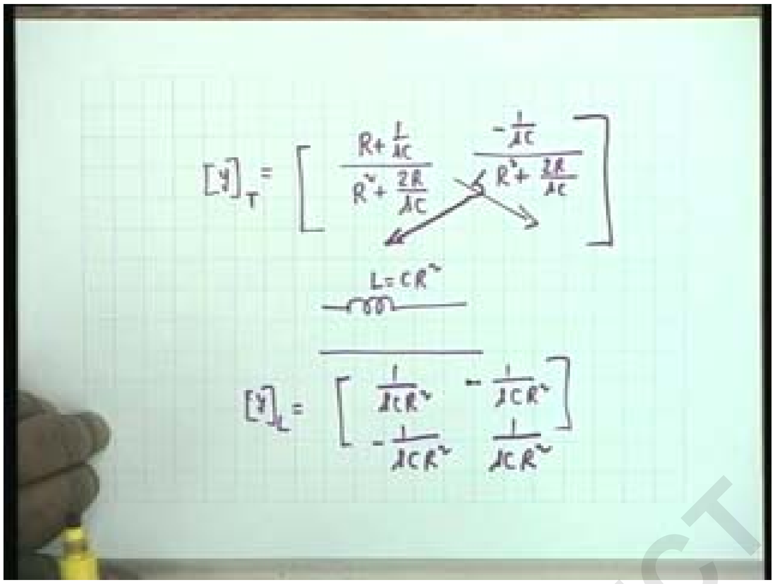

of the T network y parameters of the T network therefore is equal to R plus one over sc divided by R squared plus twice R by sc Z this is what Z one one or two two

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two two

now two two and one one are the same here because of symmetry and therefore it doesn't make a difference the two two y two two parameter is the same as this but this Z two one and Z one two parameter would be R squared plus twice R by sc it would be a negative sign and one should not loose sight of that [Vocalised Noise] that would be equal to y one two also okay y one two and y two one are equal and as far as the inductance is concerned L equal to CR squared

now here at these right at this point of time because of the special relationship it should have occurred to you and there must be purpose in choosing the inductance to be equal to CR squared so there is no point in proceeding with the general terminology L we'll put CR squared for L and the [Vocalised Noise] y parameters of the L network is obviously one over sc R squared then plus or minus

<a_side> ((plus)) (00:15:54) <a_side>

no [Laughter] minus one over sc R squared y one two or y two one will be minus all over ((sc)) (00:16:03) R squared minus one over sc R squared plus one over sc R squared okay

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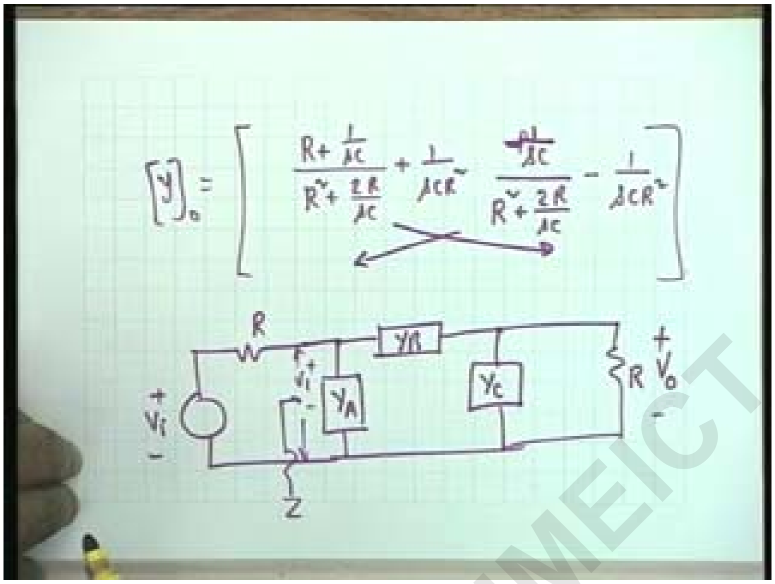

[Vocalised Noise] and therefore the total y parameters y overall would be equal to let me write down Z y one one and y two one or y one two that should be enough it would be R plus one over sc divided by R squared plus twice R by sc plus one over sc R squared and one two parameter would be

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minus one over sc [Vocalised Noise] okay minus one over sc divided by R squared plus twice R by sc minus one over sc R squared and this and this are equal okay [Noise]

now to be able to calculate the impedance [Vocalised Noise] the voltage transfer functions etcetera we require the equivalent ((phi)) (00:17:10) networks so what we do is we find [Vocalised Noise] out the network then boils down to this we have Vi R what we require is since we have found out the y parameters it is not difficult [Vocalised Noise] to find out this impedances YA YB and YC

then this is terminated in R ohms and this is V zero and this is what we want Z and we also want this voltage V one okay [Vocalised Noise] now obviously because of symmetry YA and YC are equal it suffices to find out just one of them and YB it should be obvious YB is simply minus y one two or minus y two one therefore [Noise]

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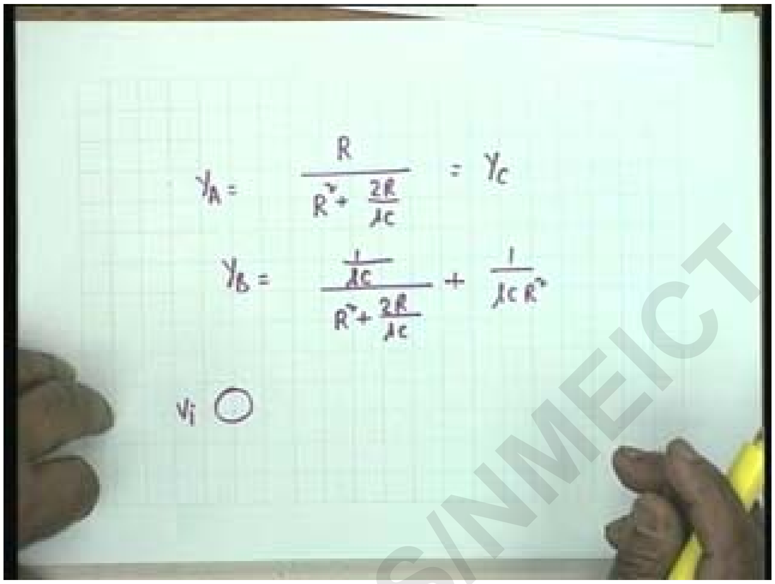

therefore YA is equal to you see the simplification it is simply R divided by R squared plus twice R by sc okay because the other things cancel minus one by minus sc and minus one by sc R squared they cancel and this is equal to Y sub C and Y sub B is simply the negative of minus Y two one [Vocalised Noise] which is one over sc divided by R squared plus twice R by sc plus one over sc R squared do you understand this

<a_side> ((yes sir)) (00:18:45) <a_side>

(( )) (00:18:45) the shunt the the bridging elements should be minus y one two okay or minus y two one and once you have done that once you have done that the [Vocalised Noise] let me go back to the network once you have done that the impedance would be this impedance would be now at this stage at this stage i would suggest that you make a simplification of this make a simplification and things shall be obvious

what you have to do is find the admittance of this combination that would be YC plus one over R then take the impedance of that let me write it down

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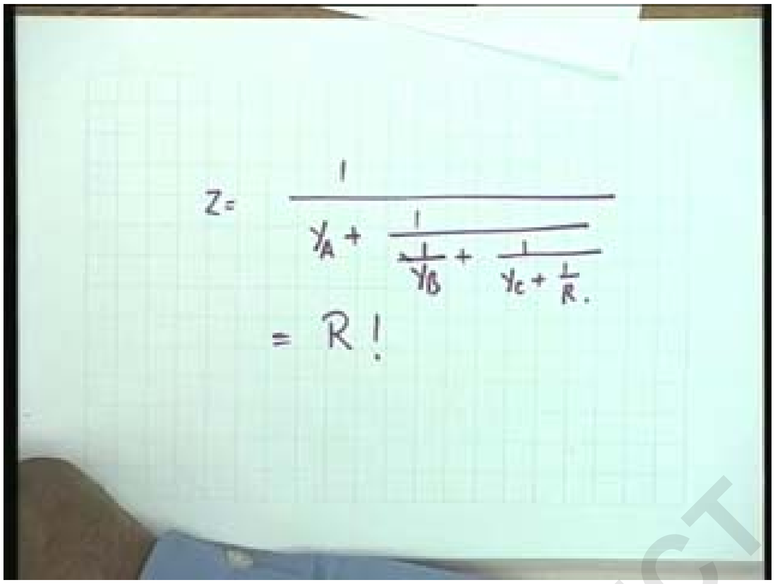

Z would be equal to one over okay let me look at this and write it down one over YA this admittance comes in parallel with an impedance okay so one over

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no i have done a mistake

<a_side> ((it should be one over by zero plus)) (00:19:56) <a_side>

okay one by one over by YB plus

<a_side> (( )) (00:20:03) <a_side>

plus one over YC plus one over R

now [Laughter] it's looks complicated but if you go systematically you will see [Vocalised Noise] that this comes simply as capital R the input {resis} (00:20:18) input impedance is simply equal to capital R and if it that is [Vocalised Noise] so if that is so let's go back to the network

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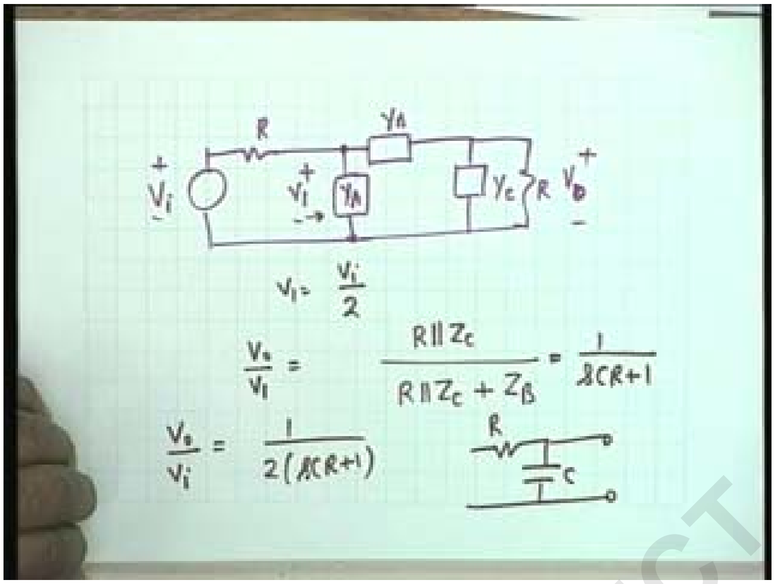

Vi R [Vocalised Noise] YB YC R [Vocalised Noise] V zero and there is a YA here this is V one if this impedance is R then obviously V one is equal to Vi divided by two is that correct if this impedance is R then Vi divides into two equal resistors and therefore V one is Vi by two and V zero by V one V zero by V one does is not effected by YA and therefore it is simply equal to R parallel ZC R parallel Zc which you have already found out divided by R parallel ZC plus ZB and [Vocalised Noise] f you substitute the values and do a bit of simplification simplification should be obvious it simply becomes one by sc R plus one

it is as if the total network you you see that it is a first order transfer function the total network behaves as a first order although there are two energies storage elements okay and it is as if what you are doing is you are taking an R isn't it the same transfer function one by sc divided by one sc plus R okay

so the total network behaves like this and obviously V zero by Vi shall be equal to half of this so one by two sc R plus one that is the correct answer the mistakes [Vocalised Noise] or ah other mistakes that you many of you committed in this is ah not [Vocalised Noise] huge the mistakes that many of you have committed are silly ones they are in simplification okay you made a mess of a very long expression and you continued with that you didn't simplify and ultimately there were problems there were also problems regarding the conversion of T into phi some of you try to try to put the formula and in a ZA ZB ZB ZB and ZC and so on so forth not from first principles i have always told you that in such simple cases do it from first principles okay and in this simplification somewhere along the line there is occurred a mistake

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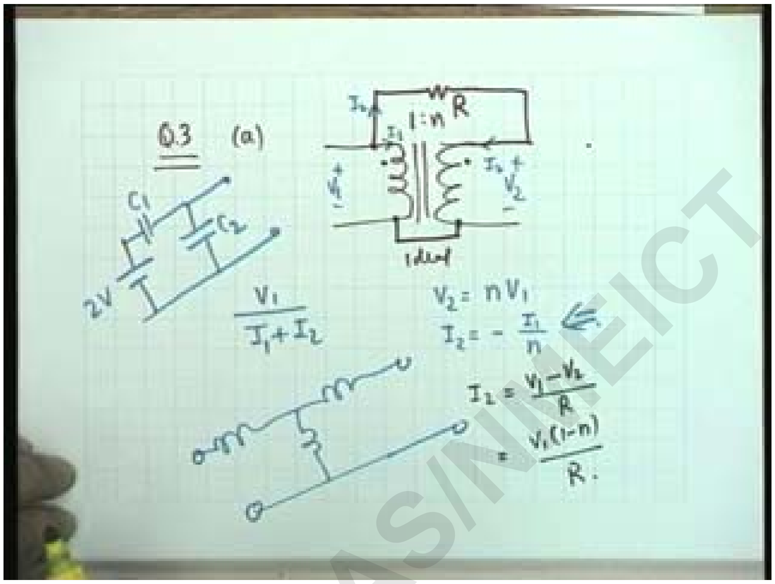

question three was to calculate two input impedances and there also what i wanted the first problem was to to judge whether you have understood what is an ideal transformer that's about all okay

it was an ideal transformer like this and you will see how simple the question is one is to n ideal and these two are connected these two are connected these two are also connected but through a resistance R

now [Vocalised Noise] the input impedances is to be calculated so we say this is V one now the mistake that you many of you did was to assume this current to be I one and it is the same as the current flowing through the primary which is not correct because there is a another path okay and [Vocalised Noise] some of you draw a line here and put a current I two here it was as if I two as dividing into two parts no i have given that this is that this has been left open and if this current is I two obviously this current is also I two and the input impedance now is V one divided by I one plus I two this is the input impedance [Vocalised Noise] that's all that one has to calculate and ah well you formulate a voltage here and since it is one is to n you get V two equal to nV one and I two equals to minus

<a_side> ((minus)) (00:25:02) <a_side>

I one by n this is the equation that many of you faltered and this is why some of you got incorrect answers

you see what you should remember among [Vocalised Noise] this is that this is an ideal

transfer so it's it should be perfectly lossless V two I two plus [Vocalised Noise] V one I one must be equal to zero this is the easiest way of remembering okay V two I two must be equal to minus V one I one yes what was your question

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you cannot you cannot because i was going to say this [Vocalised Noise] because L one and m both are infinite so L one minus m you don't know whether it is infinity or zero it is a different between two infinities and we don't know what it is an ideal transformer has primary as well as secondary inductance equal to infinity but their ratio is finite

<a_side> ((in that case you can assume I one to be negligible)) (00:25:59) <a_side>

in that case you can assume I one to be negligible no there does flow a current there does a flow a current it's a magnetizing current what is your logic for assuming this to be zero <a_side> ((sir we are saying n one is infinity)) (00:26:19) <a_side>

or so

<a_side> (( )) (00:26:22) <a_side>

okay

<a_side> (( )) (00:26:26) <a_side>

you see this is the equivalent circuit now this may be infinity this is also infinity and this is also infinity okay and therefore there occurs division between infinite inductances it's exactly like let me answer this question

if you have a battery and two capacitors let's say equal and this is a two volt battery the impedance here is infinity no current flows that doesn't mean that the capacitance do not get charged they get charged instantaneously and the voltage here shall be one volt there occurs a division between two equal infinite impedances and therefore a voltage does appear

similarly here a current does flow okay now to to complete the question this if you can write this two then obviously there is no other problem you also noticed that I two this current I two is equal to V one minus V two divided by R which means that this is equal to V two is n times V one therefore V one one minus n divided R okay and all that you required to do now is to find out V one divided by I one plus I two

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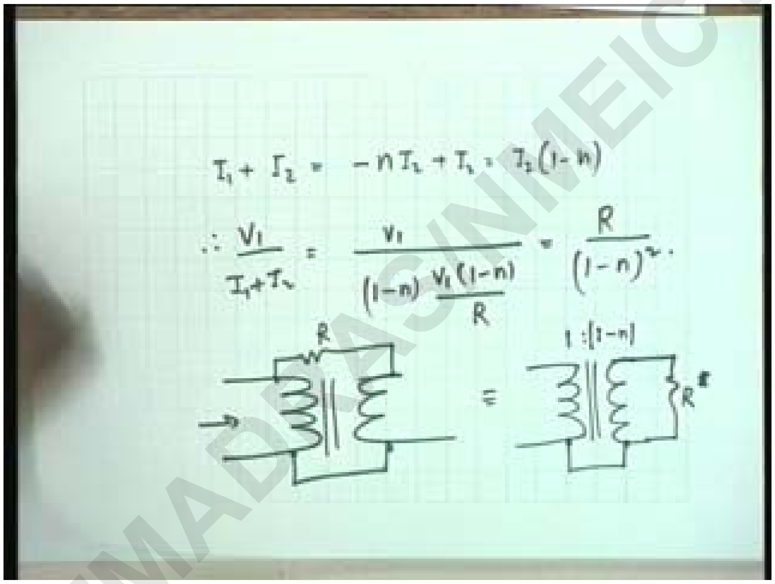

now I one plus I two [Vocalised Noise] is equal to [Vocalised Noise] minus n I two I one is minus n I two plus I two therefore this is I two one minus n and therefore V one divided by I one plus I two is equal to V one divided by one minus n then substitute for I two which is V one one minus n divided by R so this equal to R divided by one minus n whole squared that's it

one ah conclusion which i attempted to make is the following that if you have a circuit like this [Vocalised Noise] this two are connected and this is R as far as the input impedance is concerned isn't this equivalent to [Vocalised Noise] some resistance R prime here no some resist the same resistance R but it turns ratio [Vocalised Noise] instead of one is to n it is one is to

<a_side> ((n minus one)) (00:29:13)

why not one minus n

<a_side> (( )) (00:29:15) <a_side>

turns ratio cannot be negative okay therefore it is one minus n or n minus one depending on whether n is [Laughter] greater than one or less than one one cannot say definitely so you see one minus n mod because when you square it when you square it it doesn't matter alright this is one equivalent which is sometimes find useful in network synthesis problem

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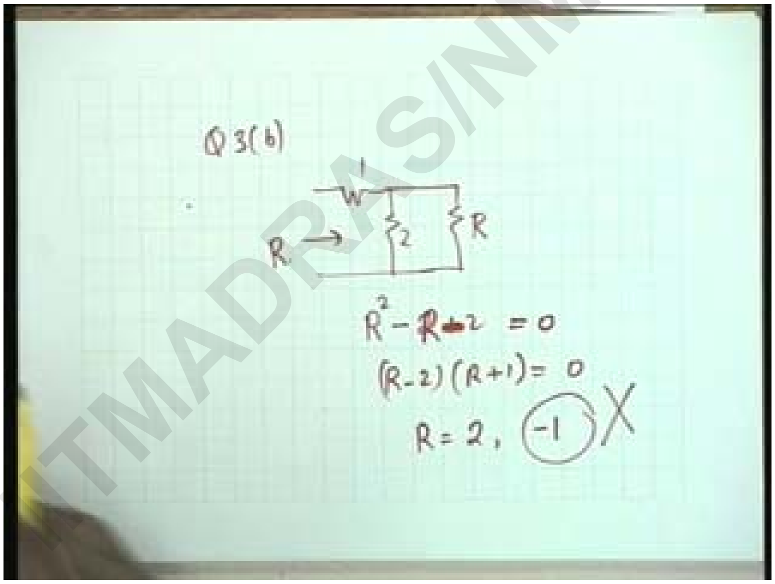

the last question question three B was simply if i am not mistaken i think i did this in the class

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no for an infinite ladder no but many of you most of you got it correctly

<a_side> (( )) (00:29:59) <a_side>

[Laughter]

not all not all because i tell you [Laughter] as far as the phrase silly mistakes are concerned this is not a monopoly [Laughter] of any particular individual there are many individuals who do commit silly mistakes and all that you have to do here is to recognize that one two and then what you see to the right is the same as the network and therefore all that you have to do is this and the input resistance then satisfies the equation R squared minus [Vocalised Noise] what was it

<a_side> (( )) (00:30:38) <a_side>

R squared minus R plus two

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no that is not correct let me see R squared minus R minus two equal to one and it was at this stage that some of you [Laughter] made a silly mistake this is R minus two R plus one equal to zero and [Vocalised Noise] it is two or minus one minus one is not possible because it's all positive resistor and therefore R must be equal to two but some of you made a mistake here in solving this simple quadratic equation alright in the is there any question no

[Vocalised Noise] in the remaining time that is left twenty minutes we would like to look at [Vocalised Noise]

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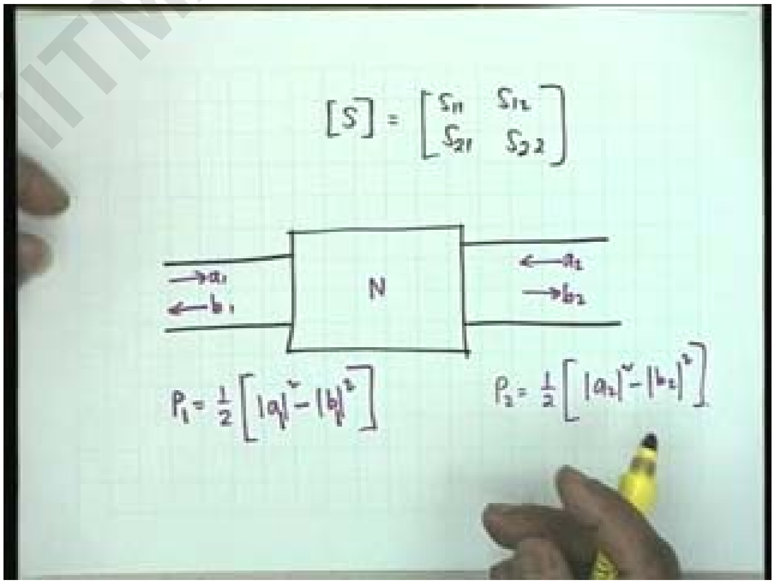

some properties of the scattering matrix if you recall the scattering matrix for a two port is S one one S one two S two one S two two [Vocalised Noise] and if we considered a two port a two port in which the incident and reflected parameters are a one and b one a two and b two

then the power that is absorbed by the network n would be the sum of the powers fed from the two ports from the two ports the power fed to the network n from this port is given by half half magnitude S squared minus magnitude b squared if you recall is it okay

<a_side> (( )) (00:32:36) <a_side>

a one squared minus magnitude b one squared alright [Vocalised Noise] why this factor half comes because we have taken a one and b one to be peak values and similarly P two the power that is fed at port number two is half a two squared minus b two squared therefore the total power that is observed by the network P

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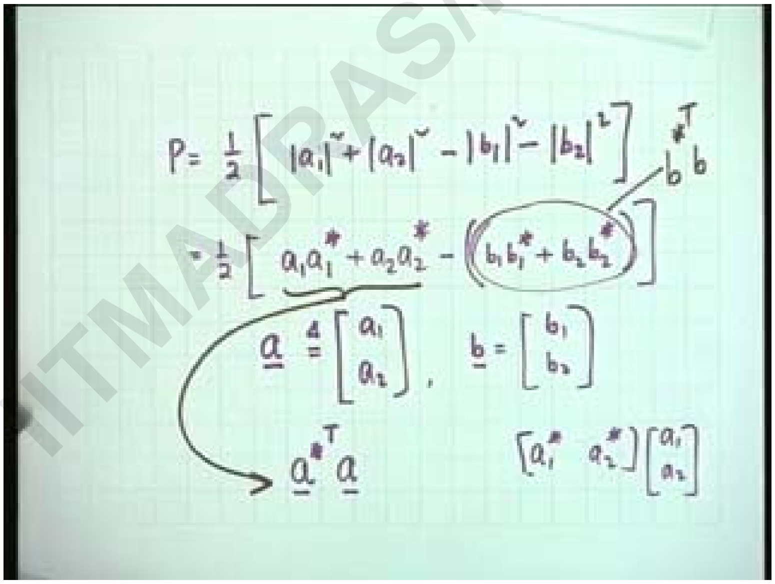

shall be given by half a one squared plus a two squared minus b one squared minus b two squared this is the total power that is fed to the network now i can write this as the magnitude i can write as a one a one star alright plus a two a two star minus similarly b one b one star where star denotes complex conjugate plus b two b two star alright now [Vocalised Noise] let us define the vector a let us define the vector a as the column vector a one a two and the vector b to denote that it is a vector or a matrix we put a we put an underline is equal to b one b two

then you see that a one a one star plus a two a two star can be written as a star transpose a is that okay this quantity can be [Vocalised Noise] written as a star transpose a if you are not convinced let's do this what is a star transpose a one star a two star okay [Vocalised Noise] this multiplies a a one a two

so you get a one star multiplied by a one plus a two star multiplied by a two is that okay simple matrix manipulation similarly this quantity b one b one star b two b two star can be written as b star transpose b alright

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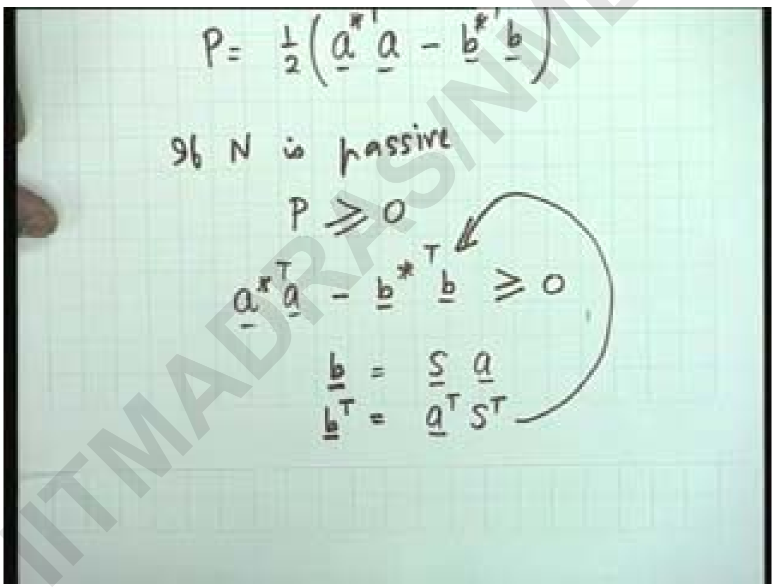

so our power absorbed by the network capital P is equal to half a star transpose a do not forget the vector signs minus b star transpose b [Vocalised Noise] and if the network is passive if n is passive then you know that this power this power has to be greater than or equal to zero P must be greater then or equal to zero

which means that a star transpose a minus b star transpose b should be greater than or equal to zero okay but you also know that [Vocalised Noise] the b parameters are expressed in terms of a parameters by the matrix S b is equal to [Vocalised Noise] Sa that is how the parameters are defined S one one S one two S two one S two two and you also know that if a matrix is transposed that is b transpose shall be equal to do you know this

<a_side> ((a transpose)) (00:36:43) <a_side>

a transpose then [Vocalised Noise] multiplied by S transpose they get interchanged their positions get interchanged okay and therefore if i substitute this in this expression

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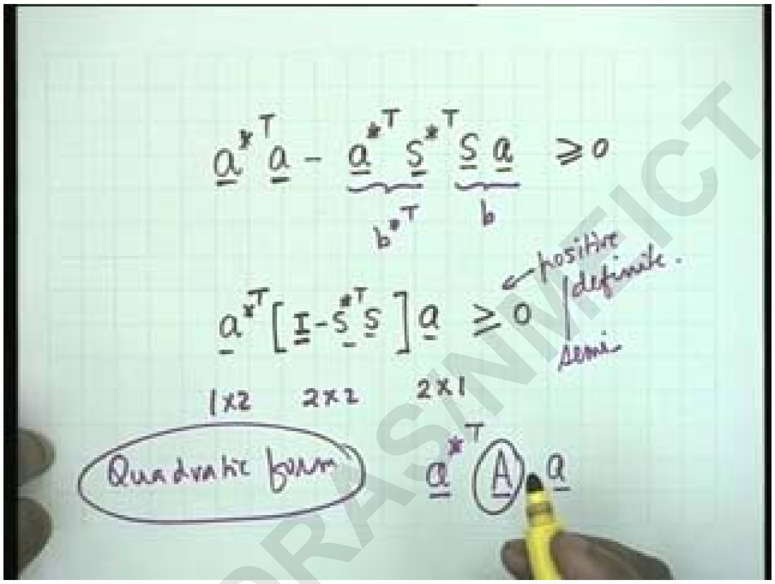

then i get [Vocalised Noise] a star transpose a minus b star transpose this will be a star transpose or transpose star is the same thing a star transpose then S star transpose then S a okay this is b star this is b star transpose and this is b this must be greater than or equal to zero

which i can write as follows you see a star transpose pre multiplies both the quantities so i can take i have made a mistake here i didn’t use the underlining to denote matrix if there is a question interrupt me if you do not understand interrupt me okay

i am doing matrix manipulations a star transpose pre multiplies both the terms and a post multiplies both the terms okay so let’s take a star transpose and a out this from the beginning and this from end under bracket then what shall i be left with from this term i shall be left with

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okay i should be left with the identity matrix of dimension two by two that is one zero zero one minus i shall have S star transpose S okay this should be greater than equal to zero

now [Vocalised Noise] this form what is the dimension of a star transpose let’s look at the dimensions what is the dimension one row and two columns and a is two rows and one column so this must be two by two in this multiplication is to be compatible then this must two by two

it is indeed so because I is an identity matrix two by two S is a two by two matrix and S star transpose multiplied by S will also be a two by two matrix okay this is two by two this is two by two this is two by two agree

such a form such a form let’s say in general a star transpose a multiplied by any matrix a would be a scalar quantity this is a scalar quantity this is the power it is twice the power actually half multiplied by this is the power okay

so this is twice the power it is a scalar quantity and the variables you see obviously these are not variables this is a matrix of constants it contains zero one one zero and S one one S one two S two one S two two okay this is a matrix of constants the variables are here the pre multiplier and the post multiplier and therefore the variables will be involved here there will be no linear term

all terms would be quadratic alright you might have a one squared you might have a two squared you might have a one a two there cannot be a term like a one or a two is that is that clear

<a_side> ((no)) (00:40:40) <a_side>

no

you see a star transpose a a shall not contain any linear term with regard to the variables alright it shall always come in product form and what does a contain a contains a one and a two so the only terms that is allowed here a one a two a one magnitude squared and a two magnitude squared because there is a complex conjugating such a form is called a quadratic form quadratic form did you come across this term earlier no it is called a quadratic form we shall come [Vocalised Noise] across quadratic form once more in this class itself and that’s why i’m tempted to introduce this at this moment

now [Vocalised Noise] it it is also it can also be proved from matrix theory that if a quadratic form is nonnegative if a quadratic form quadratic form is a scalar quantity if it is nonnegative okay the another name another name for this is positive positive definite okay

if it is greater then no this is called positive semi definite

<a_side> ((semi definite)) (00:42:05) <a_side>

positive semi definite okay

if this is equality sign is not there then it is called positive definite okay since it can be either greater than zero or equal to zero this form is also called it it is said the language is the quadratic form is positive semi definite okay

even if you forget the language it doesn’t matter all that you have to remember is that if a quadratic form is greater than or equal to zero this is possible this is a theorem this is {poss} (00:42:40) it can be very easily proved but i will not go into the proof

if a quadratic form is greater than equal to zero then this implies that the determinant of the coefficient matrix here the coefficient matrix is a the determinant of the coefficient matrix is positive semi definite which means that

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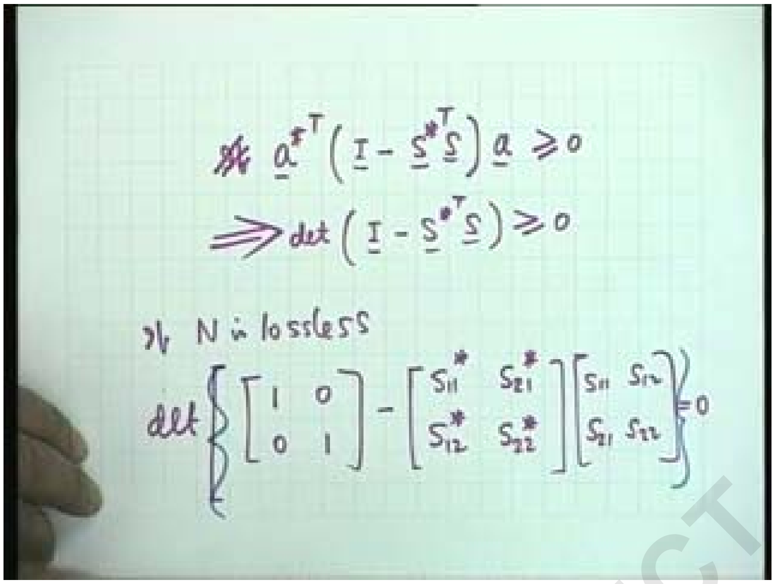

if this is so if a transpose T identity matrix minus s transpose T s a is greater than equal to zero this implies that the determinant of the coefficient matrix is greater than equal to zero okay

a quadratic form greater than equal to zero implies it can be proved that the determinant of this is greater then equal to zero alright now let's specialize the network let's specialize the network to a lossless network suppose n is lossless then the sign that shall apply here is equality sign the power absorbed by the network shall be zero

if the network itself is lossless it cannot dissipate any power it cannot absorb any power and therefore P capital P should be equal to zero which means that one zero zero one minus S [Vocalised Noise] one one star yes next term

<a_side> (( )) (00:44:28) <a_side>

no it's a transpose

<a_side> ((S two one star)) (00:44:30) <a_side>

S two one star S one two star then S two two star is it okay multiplied by S [Vocalised Noise] one one S one two S two one S two two this shall be equal to zero

<a_side> (( )) (00:44:51) <a_side>

pardon me

<a_side> (( )) (00:44:53) <a_side>

no the determinant of this [Vocalised Noise] how do i show this[Vocalised Noise] the determinant of this shall be equal to zero

now how can the determinant be equal to zero this means that that two matrices have to be identical all terms should [Vocalised Noise] be equal to zero alright

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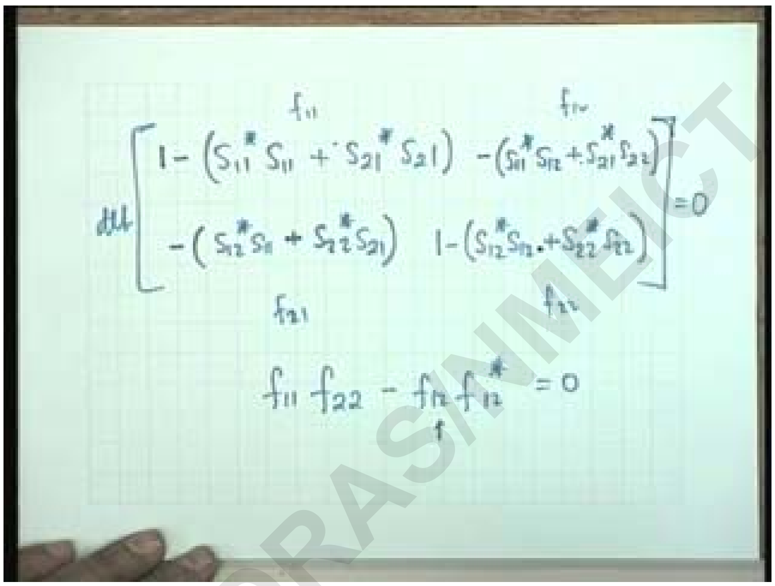

which means that [Vocalised Noise] if i now multiply S one one star

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this is not (( )) (00:45:36) pardon me

<a_side> (( )) (00:45:40) <a_side>

hmm okay let's write down the total matrix okay total matrix is one minus S one one star S one one okay the total matrix S one one what is it next

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plus S two one star S two one correct this is the first term second term is zero minus okay which means minus S one one star S one two then plus S two one star S two two okay third term is minus [Vocalised Noise] yes

<a_side> (( )) (00:46:42) <a_side>

S one two star S one one then plus S two two star S two one is it okay yeah okay and the fourth term is one minus S

<a_side> (( )) (00:47:04) <a_side>

S one two star S one two plus S two two star S two two okay this determinant the determinant of this matrix is equal to zero okay

now what is the condition what is the condition can this two diagonals both of them can be equal to zero

<a_side> ((the product of both the diagonals are the same)) (00:47:33) <a_side>

product of both the diagonals is the same okay now what is this element and this element they are complex conjugates of each other alright and therefore what it means is that if i if i call this element as let's say f one one f one two f one f two one and f two two then my f one one f two two minus f one two [Vocalised Noise] f one two star should be equal to zero okay

what is the condition [Vocalised Noise] under which this would be valid that is the question

if this is zero then obviously this is also zero then this product should be equal to zero alright can this be non zero can this be non zero f one two f one two star

<a_side> (( )) (00:48:41) <a_side>

no

why not

<a_side> (( )) (00:48:44) <a_side>

hmm

<a_side> (( )) (00:48:46) <a_side>

if f one two is zero then f one two star must be also be zero complex conjugate is zero is zero but the question is question is can we have f one two not equal to zero is that a possibility

<a_side> (( )) (00:49:04) <a_side>

okay pardon me

<a_side> (( )) (00:49:09) <a_side>

yeah

<a_side> (( )) (00:49:19) <a_side>

what becomes real [Noise]

<a_side> (( )) (00:49:25) <a_side>

you see this is a real quantity yeah that's where lies the you see this a real quantity so is this therefore the product of this two

<a_side> (00:49:38) <a_side>

is real

is real

whereas

<a_side> (( )) (00:49:41) <a_side>

no no this product S one one star S one two [Vocalised Noise] so last S two one star S two

<a_side> (( )) (00:49:54) <a_side>

that is also real correct correct

so it is a real quantity minus a real quantity equal to zero we will prove next time Thursday that that each of them has to be individually zero and i will give the logic next time