Circuit Theory

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Lecture 28

Interconnection of Two – Port Networks (Contd)

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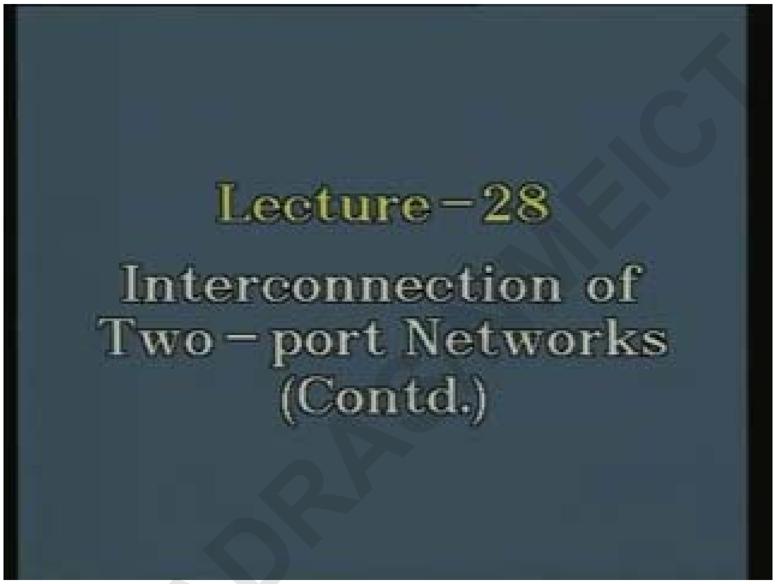

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twenty-eighth lecture on twenty-eighth February

and we continue our discussion on interconnection of two port networks

last time we had considered an example which we could not finish

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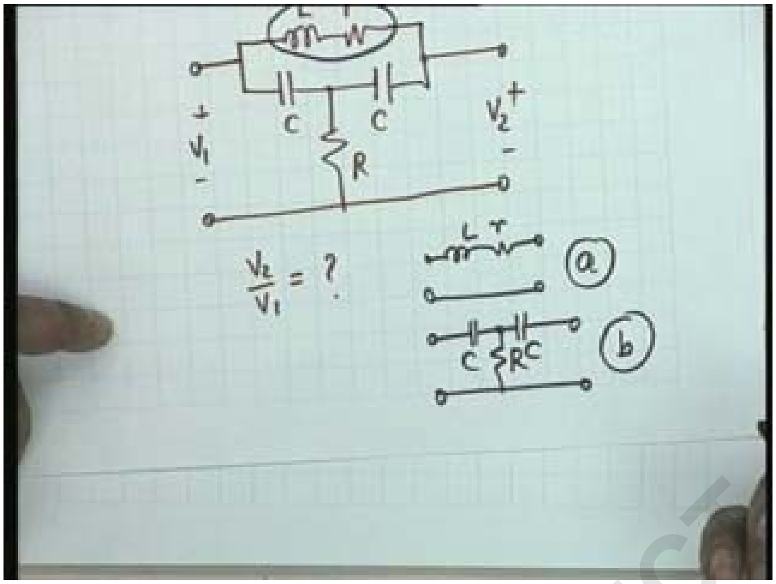

let's look at this example it is a very interesting network

we had two capacitances C C and there is a resistance R [Noise]

this is the input input port and this is the output port V two

and we said that we will analyze the network for the transfer function V two by V one V two by V one under open circuit conditions okay under open circuit conditions and we wanted to do this by using interconnection of networks

obviously this is a parallel connection of two networks one of them is Lr as i had commented this is actually a single inductance the resistance is part of the inductance all right i mention this again because this is one of the major applications of this network it is used to measure the inductance and queue of a coil inductance and its associated series resistors if the two are known then we know what queue is

so one of the network is this let's call this the a network and the other network is simply the T network C C R let's call this the b network

and you see that both of them are three terminal networks and therefore parallel interconnection will make the y parameters ((add)) (00:02:20) all right

so let's take the first network that is the a network

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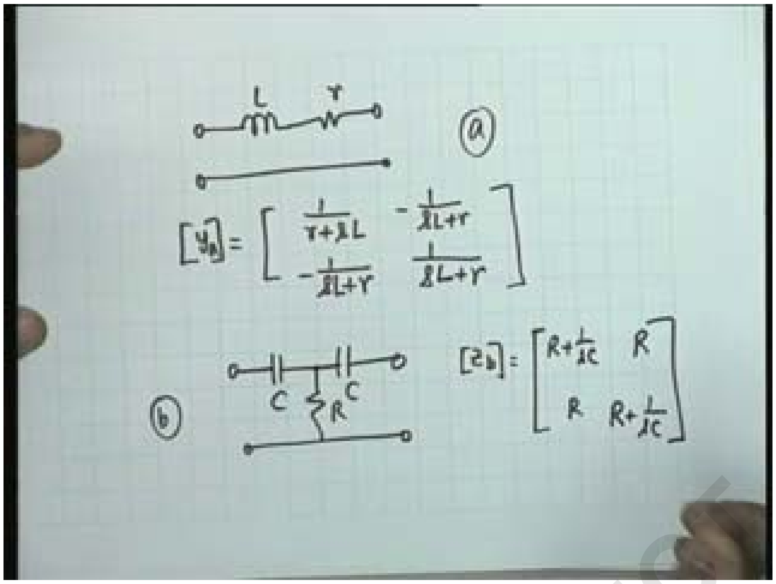

(( )) (00:02:26) again L and r the y parameters of this as is obtained by inspection is one over r plus SL y one one y two two is also one over r plus SL agreed

and if you compare this if the equivalent circuit the pi equivalent circuit then y one two is minus one over SL plus r and this is also minus one over SL plus r this is as simple as that this is the ya okay

to find yb we don’t as i said we don’t want to ((commit)) (00:03:13) to memory any formula let’s do it from the zee parameters which can be obtained by inspection

if this is the b network and you can see that zeeb the zee parameters are if this is open R plus one over Sc similarly y two two shall also be the same R plus one over Sc and zee one two shall be simple equal to R okay

so we know zee one one zee two two and zee one two this is a symmetrical network all right that means i if i draw a vertical line it's identical on both sides if you want a perfect symmetry you can break this up into twice R and twice R in parallel and draw a vertical line okay it's a symmetrical network

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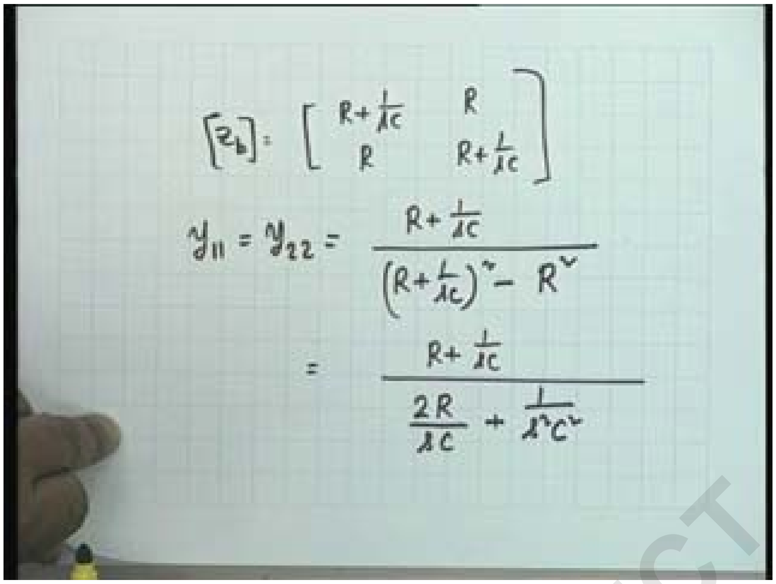

my zee parameters are R plus one over Sc i reproduce this here R and R plus one our Sc

what i am interested in at the y parameters [Noise]

and you notice that because of symmetry y one one and y two two shall be identical and this should be zee one one or zee two two that is R plus one over Sc divided by the determinant and you see that the determinate is R plus one over Sc whole square minus R squared

and therefore this is equal to R plus one over Sc in the denominator R square shall cancel and i shall get twice R divided by Sc plus one over s squared C square

let's leave it like this for the present okay

this is my y one one y two two

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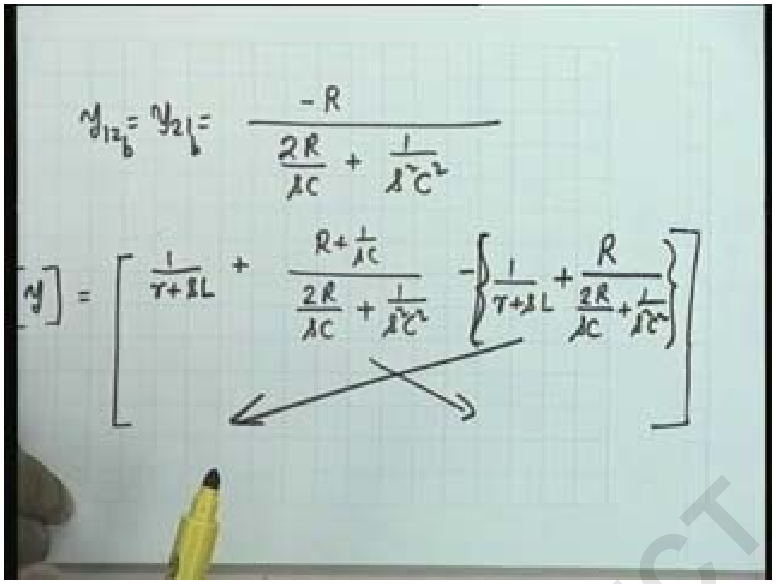

then my y one two and y two one shall be equal to minus zee one two which is minus R divided by the same determinant we have already found out the determinant so two R by Sc plus one over s squared C squared agree

so we found out the V parameters they are (( )) (00:05:31) parameters for the b network and therefore for the bridged T network while this network incidentally has the architecture of a T this is a T which has been bridged from input to output through Lr Lr is the bridge so it is called the name is bridged T okay bridged T network [Noise]

therefore the y parameters of this network shall be simply the summation of the two y parameters so it would be one over r plus SL that was for the a network plus y one one b which is R plus one over Sc divided by two R by Sc plus one over s square c square all right and the y two two parameters shall be the same y one one and y two two shall be the same

whereas y one two shall be minus minus let's use a another brackets minus one over r plus SL plus simply R divided by two R over Sc plus one over s square C square is that okay is that okay

we are adding the y one two parameters y one two for the b network is right here and y one two for the [Noise] a network was minus one over R plus SL so i have combined the two okay

and this will be the same as y two one parameter

and therefore i have found out the total network admittance matrix

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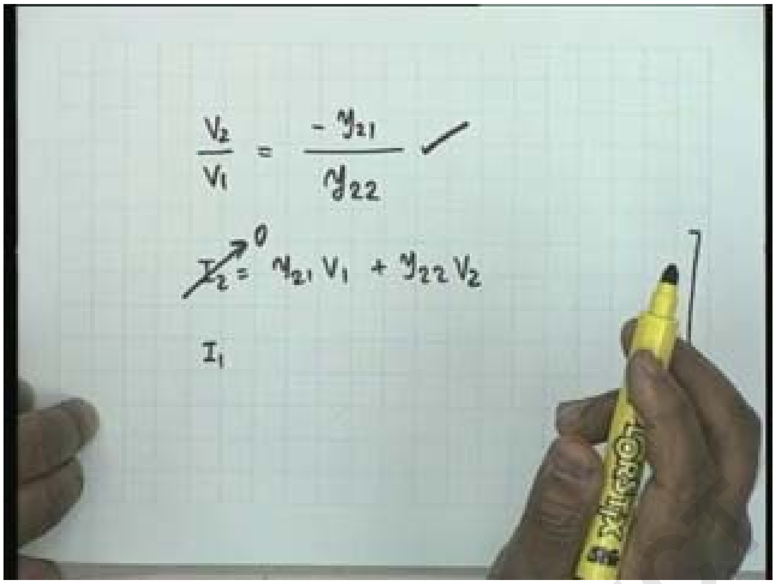

and if i do that [Noise] if i if i founded the total admittance matrix then what is V two by V one under short under open circuit conditions V two by V one in terms of y parameters is given by

<a_side> minus y one one by y one two <a_side>

no (( )) (00:07:58)

<a_side> it's actually the open circuit <a_side>

open circuit you take the second equation I two is y two one V one plus y two two V two

if I two is zero than V two by V one would be minus y two one divided by y two two

<a_side> sir why can't we take if from the first one (( )) (00:08:22) <a_side>

first one

<a_side> input parameter <a_side>

i don't know [Laughter] the input current i have to take from the second one that was the whole idea in finding the y parameters that i can express in terms of y two one and y two two

and therefore my transfer function

is there any question at this point

<a_side> sir is that there is a general rule that uh y parameters add up (( )) (00:08:46) if ah if the circuit is not changed <a_side>

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that is correct y parameters add if the character of the two component circuits are not changed because of the parallel interconnection

<a_side> this sir if that the same as the zee parameters <a_side>

same no [Laughter] zee parameters will take up zee parameters (( )) (00:09:06) zee parameters add if the networks are connected in series which we shall see in a in a few minutes

let me complete this okay

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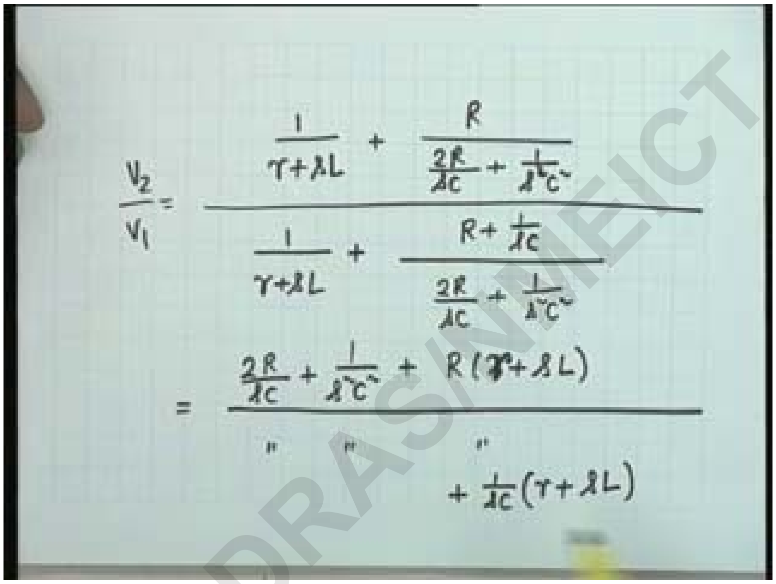

now [Noise] the reason why i am going through this example is that this a very interesting network

if you write the expression V two by V one with the parameters that have already been found out you will see that this is one by r plus SL the negative sign is cancelled because minus y two one divided by y two two plus R divided by twice R by Sc plus one by s squared C squared

and in the denominator is it okay minus y one two in the denominator all that i need to change is the numerator of the second term the denominator is the same twice R by Sc plus one over s squared C squared and in the numerator we shall have R plus one over Sc agreed

so i simplify this i simplify this by multiplying by R plus SL multiplied by this

then in the numerator i get by inspection twice R divided by Sc plus one over s squared C squared plus capital R multiplied by r plus SL all right

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and in the denominator in the denominator i shall have always three terms plus an additional term which would be one by Sc multiplied by r plus SL okay

so i can write this [Noise] let me write this again

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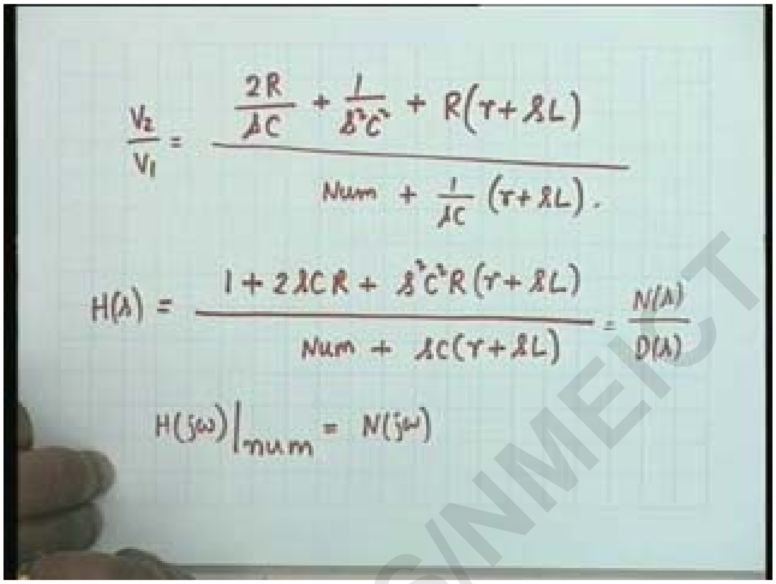

V two by V one is equal to twice R divided by Sc plus one over s squared c squared plus capital R r plus SL divided by numerator plus one over Sc r plus SL agreed

let me clear these terms of s squared c squared that is i multiply both numerator and denominator by s squared c squared all right

then i get this as equal to if i multiply by s square C square this term gets into unity plus two Sc R plus s squared C squared R multiplied by r plus SL and in the denominator i shall get the same term as the numerator plus Sc r plus SL is that okay all right

let me call this an H of s a transfer function then you notice that H of j omega numerator let me take only the numerator okay

let's call this as N of s by D of s

then this is equal to N of j omega it's a polynomial in s let's put s equal to j omega then we get

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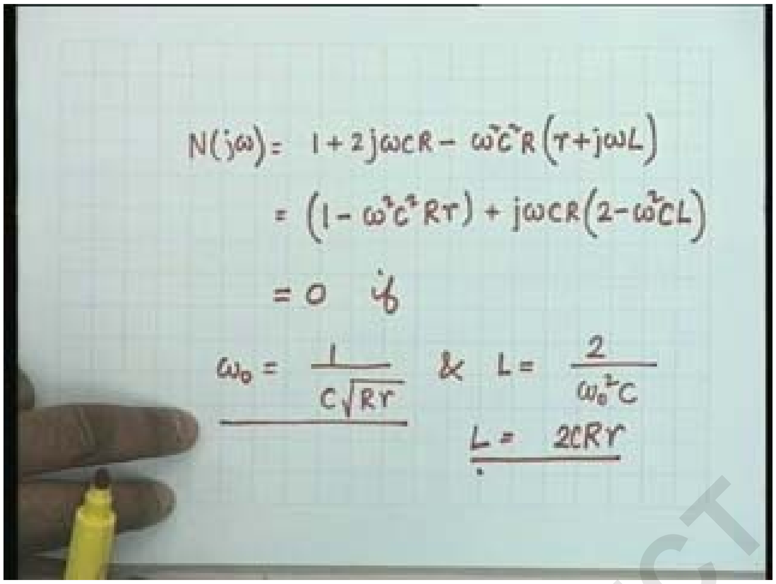

N of j omega the numerator as equal to one plus twice j omega CR minus omega squared c squared R multiplied by r plus j omega L all right

let me collect the real and the imaginary parts is that okay

s squared goes as minus omega squared and s goes as j omega

let me collect the [Noise] the real and imaginary parts i get one minus omega squared c squared Rr okay [Noise] plus j omega CR two minus omega squared

<a_side> c squared <a_side>

not c squared

CL is that all

i have taken omega CR so omega C okay fine omega squared LC

now we investigate the possibility whether this can be zero or not

can this be zero if it is so then the real part as well as the imaginary part should ((vanish)) (00:14:22) identically all right which means that s indeed it can be zero {e} (00:14:30) at the frequency omega naught which is equal to one over c square root Rr is that okay

the real part equal to zero under what condition or the frequency satisfies this and both must be satisfied and L should be equal to

<a_side> (( )) (00:14:58) <a_side>

no

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two divided by omega naught squared C which is equal to ((yes)) (00:15:10) if i substitute for omega naught square from here

<a_side> (( )) (00:15:14) <a_side>

omega naught squared C

<a_side> (( )) (00:15:18) <a_side>

two

<a_side> (( )) (00:15:19) <a_side>

no it

<a_side> (( )) (00:15:24) <a_side>

two Rr into C not divided by okay so twice two CRr L should be equal to twice CRr all right

now [Noise] under this condition what happens to the denominator

you see when inductance satisfies this relation and a frequency satisfies this relation what happens to the denominator is the denominator also equal to zero

no

denominator is zero plus a quantity which is not equal to zero

if it was zero by zero form then we would not have been in trouble but it is a zero divided by a non zero term

and therefore what is the conclusion that the output voltage shall be exactly zero when the inductance and the frequency satisfy these two conditions all right

and so this is also a notch network exactly like the parallel T network

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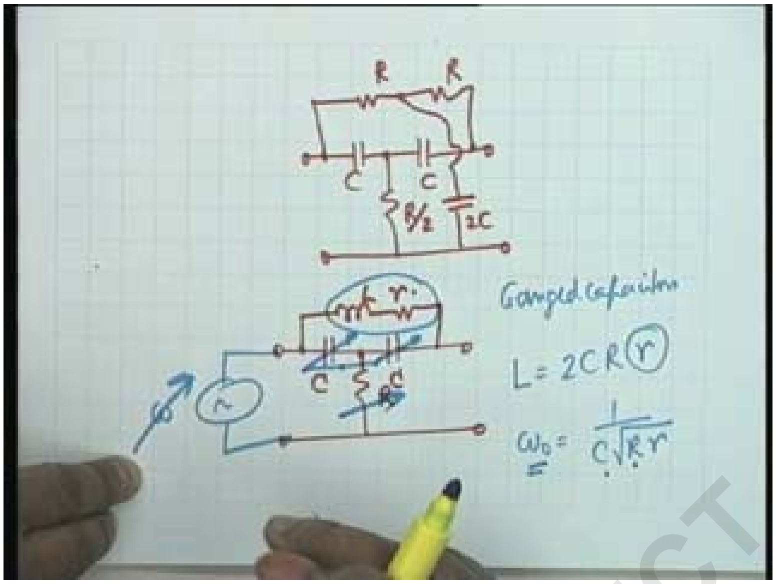

you recall that the parallel T in which we had a C C then what was this

R by two and then we had ((an)) (00:16:43) RR and two C exactly like this our bridged T network is also capable of giving a null transmission at a certain frequency

now [Noise] let me draw this network then i will tell you what use it can be made of CCR and then Lr the use that is made of is to measure an unknown inductance Lr

and how it is measured is

you vary what are the things that you can vary

<a_side> (( )) (00:17:26) <a_side>

C and C these have to be varied simultaneously because you have to keep them identical and in the market there are available what are known as ganged capacitors ganged ganged capacitors two identical capacitors which vary simultaneously [Noise] okay so two ganged capacitors then you can also vary capital R okay or you can vary the frequency [Noise] of the source all right

what you do is if you wish to vary only C and the (( )) (00:18:09) source set these to a particular value and vary omega till you get approximately a null

then at that point you vary C to sharpen the null and you go ahead doing this alternately till you get absolutely zero transmission at a particular frequency and at that frequency the value of L would be twice CRr multiplied by small r which you do not know but small r is obtained from the frequency that is Cr capital R you know C and R if you know omega zero then you know small R and therefore you know capital L as well as [Noise] small r

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this is the basis of one of the ((Hewlett Packard)) (00:18:56) instruments for measurement of inductances and it's queue all right

a bridged T network it's one of the one of the most useful networks in electronic measurements and instrumentation

and i thought i would do this [Noise] completely

any question

and i did this analysis through interconnection of two ports i used i looked at it as an interconnection of two ports parallel interconnection and a favorable parallel interconnection that is a three terminal network paralleled with another three terminal network and therefore y parameters add without any hesitation without any reservation all right okay

now the question was what ((happened)) (00:19:42) if you connect two networks in series

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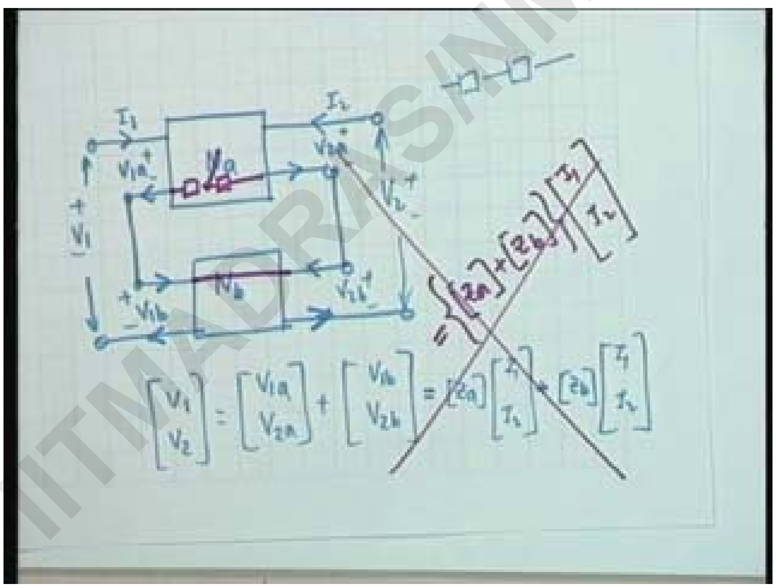

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let's look at that

suppose we have a network Na [Noise] and the network Nb

now series interconnection means series interconnection means that the same current just like two impedances if they are connected in series it means that the same current flows through both the impedances

here here series interconnection of two two ports means that the same current flows through the identical ports of the two networks in other words what we simply do is connect this to this then you know if this is a port the current here should be equal to the current here and if this a port and the current here should be equal to be current here in other words the same current should flow uh through both the first ports of the two networks

in a similar manner a series interconnection at the output port shall mean that you connect these two then this current and this current shall be identical and this current and this current should be identical all right

if you call this I two and if you call this I one then I one is the port current of Na as well as Nb at port number one and I two is the port current of Na as well as Nb at port number two

however there is a problem

the problem is well before i come up to the problem if the two voltages are V one and V two [Noise] of the composite network that is two networks are connected in series then you notice that V one is the sum of V one a and V one b okay

V one is this plus this

similarly V two is the sum of V two a and V two b okay

and therefore it is logical to say that V one V two this matrix is the sum of these matrices V one a V two a plus V one b V two b [Noise] and each of them is the zee matrix multiplied by the current matrix

and therefore zee a I one I two same current plus this point clear

V one b V two b is is related to I one I two by the matrix zee b and therefore it is natural to conclude that the zee parameters add

that is this should be equal to zee a plus zee b multiplied by the column vector I one I two

however as i said there is a problem [Noise]

a problem is that if this interconnection changes the character of either network either or both then you must be careful

for example the Na could be a network like this Na could had two impedances like this and a connection from here and Nb may have a short circuit here

then you see connecting this like this it is changing the character of Na because the two lower terminals are being bridged by a short circuit

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and therefore all these procedure shall not work

the connection [Noise] the addition of zee parameters shall be valid only under the condition that the interconnection don't change the character of either networks all right

and typically we could have done this if this was also a short circuit then the zee parameters would have added

and therefore to add the zee parameters as in parallel interconnection we use a transformer

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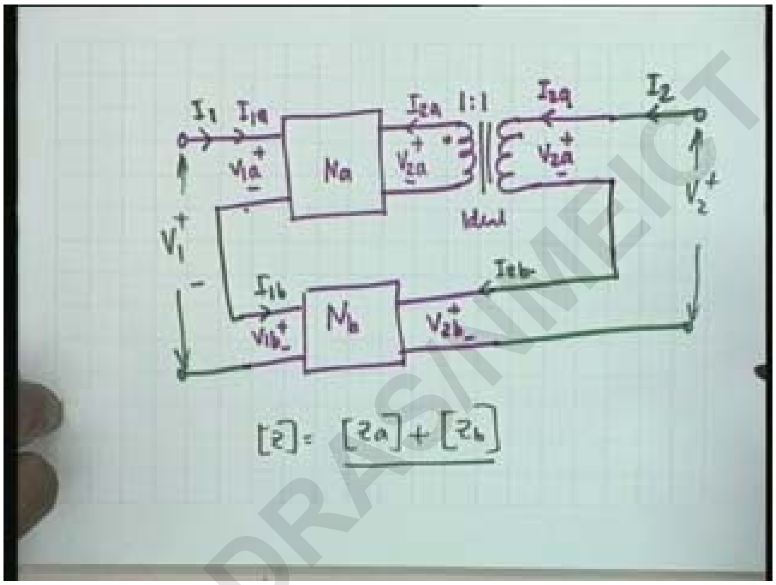

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that is in general our network would be like this Na and instead of connecting directly we shall use a one is to one ideal transformer one is to one ideal transformer

and [Noise] the voltages suppose this is V one a and this is V two a the current is I two a and this current is I one a then if this is a one is two one transformer then what is the voltage here

same V two a and what is the current here

I two a

and therefore these voltages and currents are transfered to the secondary with physical isolation and therefore therefore now a series connection will not change the character of the two networks

in other words we can have an Nb in which this is V one b this is V two b and [Noise] i can now make the series interconnection that is what i do is i connect this to this and take this out here this voltage is I two this current is I two b okay and this current is I one b i make the series interconnection and i extend this

so this voltage now is V one and this voltage is V two and you notice that I two a and I two b at the same and the same as I two for the composite network [Noise]

similarly I one a and I I one b are the same and equal to the I one of the composite network and it satisfies the conditions that V one is equal to V one a plus V one b

similarly V two is equal to V two a plus V two b therefore the zee parameters add

that is zee parameter of the total network is zee a plus zee b

questions

you want me to go through this again

yes

yes okay

first question is why did you require this transformer [Noise]

we showed we showed that if we connect networks in series without paying ((it)) (00:27:42) to whether the internal character is being disturbed or not we shall not succeed in finding the zee parameters all right because one of the networks maybe disturbed

therefore we use a one is to one transformer to keep the voltages and currents intact one is to one ideal transformer so whatever voltage and current here are they reflect here

now i can connect because physically this point and this point or isolated from each other okay these two points are isolated from each other and they may be connected to any any {ib} (00:28:22) bridging terminal any bridging connection for N ((sub b)) (00:28:27) it doesn't matter is doesn't change anything in either network Na or Nb all right

then we argue that because of series interconnection the current I one a and I one b are the same as I one similarly current I two is the same as I two a or I two b

on the other hand the voltages at the two ports are sum of the two voltages of the two networks V one is V one a plus V one b V two is V two a plus V two b

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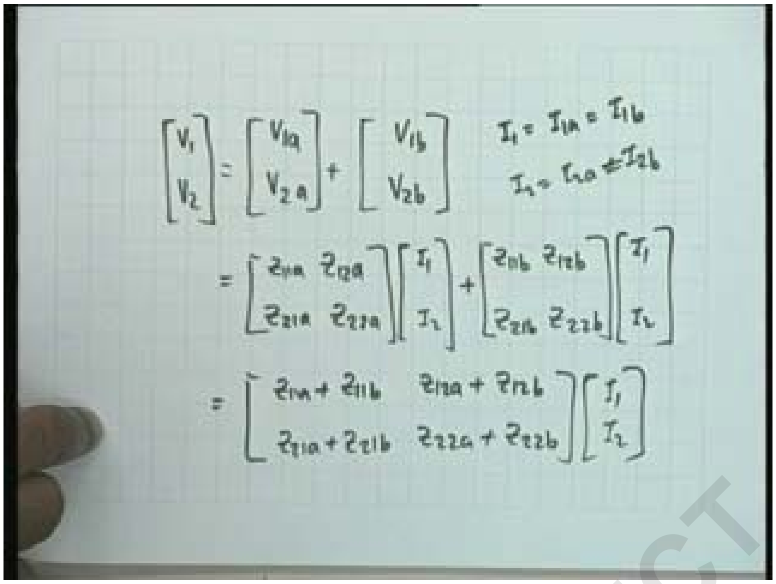

therefore let me repeat the procedure V one V two is equal to V one a V two a plus V one b plus V two b

and V one a V two a is zee one one a zee one two a zee two one a zee two two a multiplied by I one a I two a which are the same as I one and I two okay

similarly for V two V one b V two b we write zee one one b zee one two b zee two one b zee two two b multiplied by I one b I two b which are the same as I one and I two

this happens because I one equal to I one a equal to I one b

and I two equal to I two a plus equal to I two b which means that now because this matrix is the same as this matrix's i can simply combine them into zee one one a plus zee one one b zee one two a plus zee one two b zee two one a plus zee two one b zee two two a plus zee two two b multiplied by I one and I two and it is obvious that the zee parameters have added

if you do this without paying attention to the architecture of the two networks you {im} (00:30:50) you must be very and {en} (00:30:52) you might be an easy prey to making a mistake

what kind of mistake

a two port mistake [Laughter] or an interconnection mistake okay

so you must pay (( )) (00:31:05) to what is being connected and how are they are being connected

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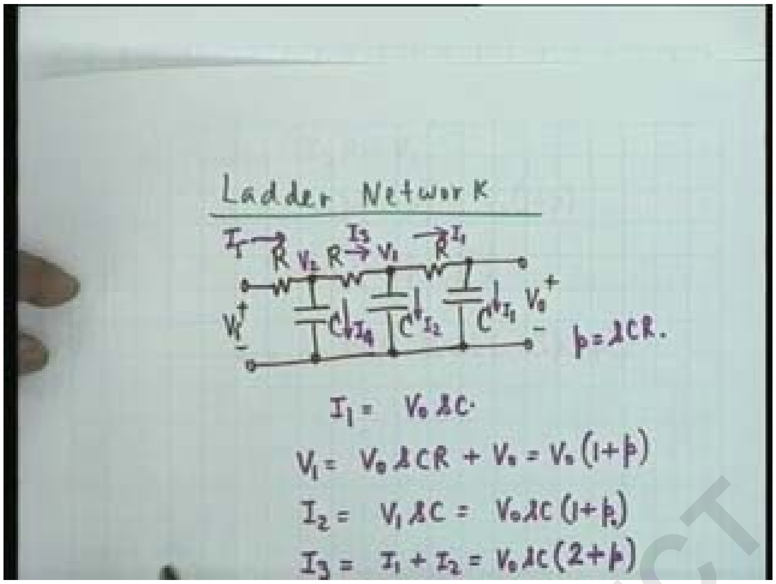

we ah [Noise] conclude this discussion on two ports ah this part of discussion with a special kind of two port namely a ladder network

in the previous problem solving session we had already considered an example of a ladder network and we had illustrated a particular method of analysis a particular method analysis by starting from the output end and going towards the input end well this method has been found to be very simple you don’t have write loop equations node equations or anything else no simultaneous equations and so on

and what i shall what i shall do is instead of taking the general case and showing i will take a particular example an example i have been insisting that you you do it i shall do it today as an example of ladder network analysis and then i shall illustrate some interesting ah [Noise] variations of this procedure

i (( )) (00:32:25) an identical three section ladder and i want to find the transfer function V zero by Vi i had commented that this is a network which is used for phase shifting by hundred and eighty degrees and is used in an oscillator called phase shift oscillator all right

now [Noise] to ah to analysis this what i do is i proceed like this first i find this current let me use a [Noise] first i use this current let me call this as I one all right

so I one is equal to V zero Sc okay and this current is the same as I one because this is open circuit and therefore then i will call this voltage as V one

so V one would be equal to I one R that means V zero SCR plus

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<a_side> V zero <a_side>

V zero i write this as V zero one plus let's say p i don’t want to write SCR again and again let me write this as p okay p is the new variable it's a (( )) (00:33:50) original variable multiplied by a constant CR okay

after i find after i found out V one then i find this current let's call this current as I two

then I two is equal to V one times SC which is equal to V zero SC multiplied by one plus p all right

after i found out I two then i find this current let's call this I three

you notice that I three is equal to I one plus I two and therefore this is V zero SC I one plus I two multiplied by two plus p is that okay [Noise] right

i have added this and this i V zero SC taken common so it becomes two plus p all right

after i found out I three then i will find V two this voltage

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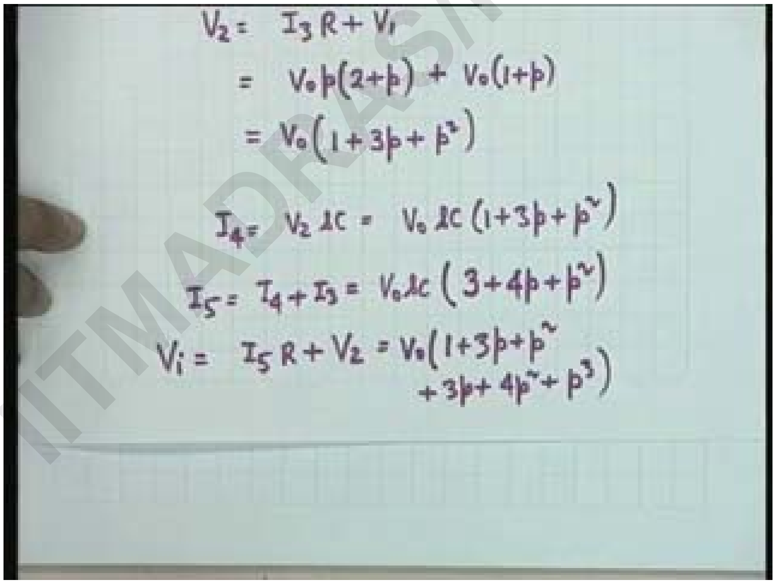

obviously V two is equal to I three R plus V one and I three R would be V zero p two plus p why because I three is V zero SC you multiply by R so V zero SCR multiplied by two plus p plus V one we have already found out to be V zero one plus p

so this is equal to V zero yes one plus three p plus p squared agreed V zero plus one plus three p plus p squared then after i found out V two i find this current let's call this as I four I four

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I four is equal to V two times SC that is V zero SC one plus three p plus p squared all right

and finally you see finally this current I five I five shall be the sum of I four and I three

so I five is equal to I four plus I three is equal to V zero SC can be taken common

<a_side> (( )) (00:36:19) <a_side>

the constant would be three plus four p plus p square all right

I three (( )) (00:36:30) I five was found out and therefore finally what remains to be found out is Vi Vi is I five R plus V two Vi is I five R plus V two plus this voltage

now [Noise] if i substitute you notice that i have to multiply this by R so i will get V zero and add to this okay add to V two so i will get let me do this one plus three p plus p squared plus what shall i get from the second term I five R three p plus four p squared plus p cube all right and i have obtained what i wanted to obtain [Noise]

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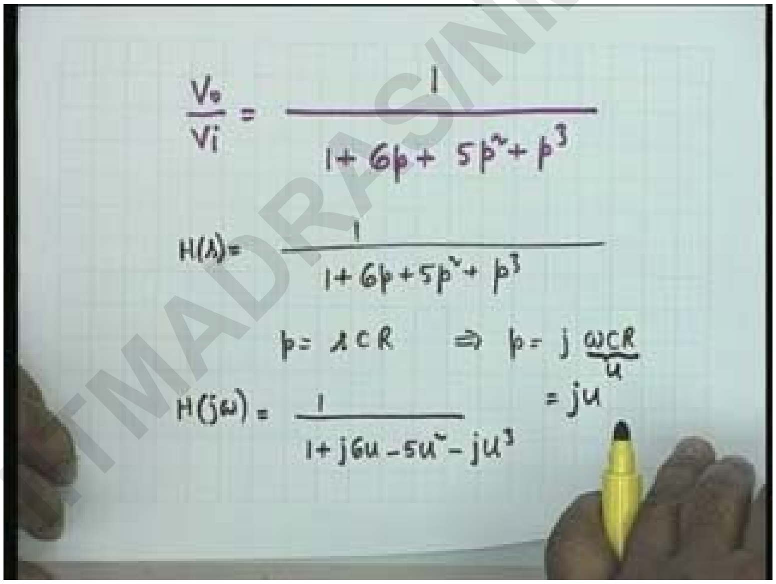

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that is i have obtained V zero by Vi this is the transfer function i wanted this should be one by one plus six p plus five p square plus p cubed okay

not only that i have not only found out the transfer function i have also found out all the currents and voltages in the networks isn't that right

you see the the byproduct of this procedure is that i have find out all currents and voltages in the network agreed

for example if one wishes to take a voltage from here okay we know what is V one by V i or if this current is of interest we know that also

so it is a complete analysis of the network if i if i so require i can find out now the input impedance input impedance means Vi divided by I five correct or any other transfer impedance for example I one divided by Vi [Noise] i know that also

i know everything all network functions i can find out y the zee parameters y parameters any any parameter for example okay i know everything that i need to know all right [Noise]

<a_side> sir this ladder network is for three capacitance then how can we (( )) (00:38:54) for n capacitance <a_side>

for any capacitors no for n impedances any combination of impedances okay

let me tell you what is a a general ladder is it looks like the architecture is the (( )) (00:39:06) ladder lying on (( )) (00:39:08) ladder usually is two two rods like this and then bridges okay that’s that’s what is a ladder it's lying on its side so that’s the architecture

and this procedure can be extended to any ladder network any ladder network start from the output and go towards the input

and all that you have to do is to find currents in the (( )) (00:39:32) terms and voltages across the series amps that’s all and there is no simultaneous equation there is no node equation there is no loop equation there is nothing a simply a common sense and going backwards okay

now let me illustrate the important property of this network with the transfer function

let's call this transfer function as H of S is equal to one by one plus six p plus five p squared and p cubed

and p as you remember is SCR all right

if S is j omega under sinusoidal excitation

then H of j omega if S is j omega you can write this p as j omega CR all right

call this as u that is write p as equal ju

and you want to write omega CR again and again

then my H of j omega would be one plus j six u minus five u squared u is a real quantity

<a_side> yes sir <a_side>

okay

then plus p cubed that would be minus ju cubed is that okay all right

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so i continue this in the next page

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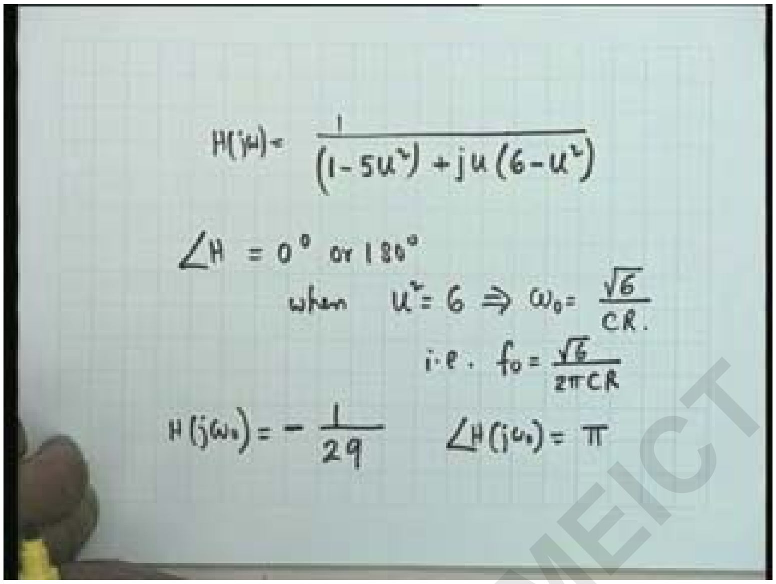

H of j omega is equal to one by let me collect the real terms and the imaginary terms plus ju six minus u squared okay is that okay

the phase shift the angle of H of j omega angle of H shall be either zero degree or hundred and eighty degrees if the imaginary part in the denominator is zero if the imaginary part in the denominator is zero then H of j omega is purely real it can of either a positive sign or a negative sign is the point clear if it is a positive sign then the phase shift is zero if it is the negative sign then the phase shift is hundred and eighty

so it is either zero or one eighty when u squared is equal to six which means that the frequency omega naught would be equal to square root of six divided by CR is that okay u squared is omega naught squared C squared R squared that is six

that means at a frequency f zero which is equal to square root six divided by two pi CR okay

and at this frequency H of j omega zero the value of the transfer function would be equal to one by u squared is six and therefore [Noise] one minus thirty that is twenty-nine and therefore it is minus one by twenty-nine

you see why it is minus

< a_side > (( )) (00:42:55) <a_side >

and therefore the phase shift (( )) (00:43:00) of H of j omega zero is equal to pi hundred and eighty degrees okay

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now let's see how this network is used in a phase shift oscillator

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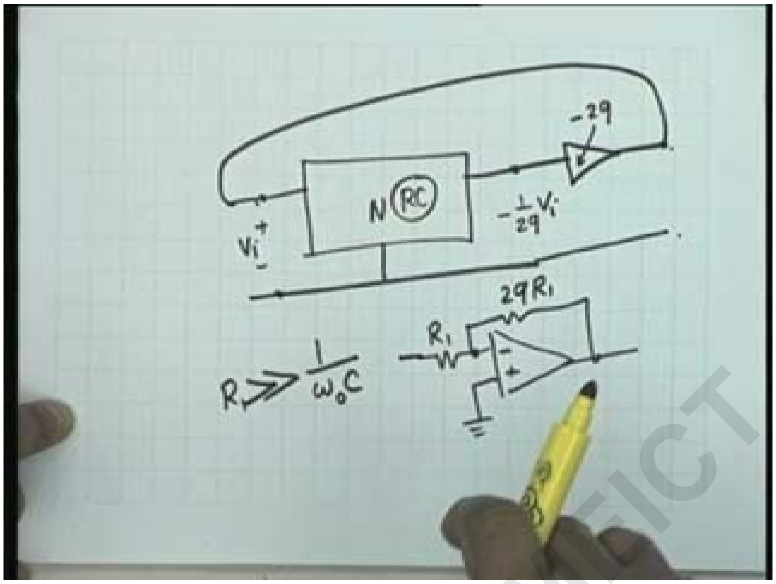

let me show the network as simply N

it is a three terminal network okay it is a three terminal network RC network [Noise] at omega zero at omega zero this voltage the output voltage is minus one over twenty-nine times the input voltage if this is Vi okay

suppose now i connect from here an amplifier of gain minus twenty- nine that is the amplifier is a gain of twenty- nine and a phase shift of hundred and eighty degrees

then this voltage this voltage should be exactly equal to Vi isn't that right

this is minus one by twenty-nine Vi multiplied by minus twenty- nine then this should be exactly Vi which means that i can connect these two points without any disturbance and the active network then is forced to adjust its input and output such that this voltage is exactly equal to this voltage and this is the condition for oscillation okay this is the condition for oscillation

and therefore without any input without any input no input is connected you simply connect the RC network and the active device which can be an (( )) (00:44:50) it can be an (( )) (00:44:52) with a negative gain therefore you will have i am sure you have studied this this should be twenty-nine times R one and this should be R one correct

the only problem is you know the network N has its last element as a what is the last element a capacitor okay

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this capacitor will see an impendence of R one therefore the R one should be much larger than the impendence of the capacitor R one must be much greater than one by omega naught C at this frequency then the network performance shall not be disturbed agreed

and you will get a frequency you will get pure sinusoid at the frequency root six divided by two pi CR Hertz okay

there are many questions that can arise at this stage which will be answered which had perhaps been answered or which will be answered in the course on analogue electronic circuit as to who starts the oscillation how does the network know that it has to how does this circuit know it has to oscillate no it doesn't have to know because any point in nature any point whatsoever has associated with it some amount of noise

and in electrical circuit there will be a noise component here and the noise is usually a wide band noise wide band spectrum from which this particular frequency omega naught which is roots which is root six by CR is appropriate for going through this loop and sustaining itself

so all other frequencies are rejected and it is the only one which is sustained sustained for oscillations and therefore it oscillates

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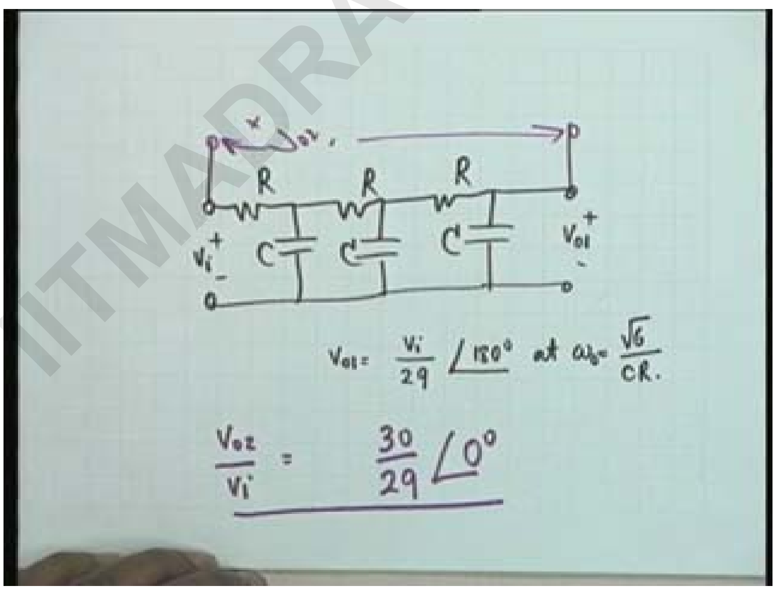

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let me ah tell you something else about this network it's a very interesting network

suppose i have the same network and you know that let me call this Vo one and this is Vi okay then you know that note this carefully please you know that Vo one is equal to Vi divided by twenty-nine angle one eighty at omega naught equal to root six divided by CR this we have proved

that this voltage is one twenty-ninth of this {withena} (00:47:54) with a phase shift of hundred and eighty degrees [Noise] okay

suppose instead of [Noise] connecting like this [Noise] well suppose i take the i take an output voltage here [Noise] please note carefully what i am doing

suppose instead of taking the output here i take the output here V zero two all right then what can you say about V zero two divided by Vi what can you about say about this transfer function

< a _side > ((twenty-eight by twenty- nine)) < a _side >

this should be

< a _side > ((twenty-eight by twenty-nine)) < a _side >

twenty-eight by twenty-nine oh why is that

<a_side> (( )) (00:48:50) <a_side>

i don’t take (( )) (00:48:52) okay why don’t i agree

< a_side > ((thirty by twenty-nine)) (00:48:57) < a_side >

thirty by twenty-nine that is correct

and the angle

< a_side > zero degree < a_side>

zero degrees is this obvious it is obvious because Vi is equal to V zero two plus V zero one simple KVL

so what you see between this point and these two points the phase shift is zero degree and the gain is slightly greater than one one plus one by twenty- nine agreed

<u>(Refer Slide Time: 00:49:43 min)</u>

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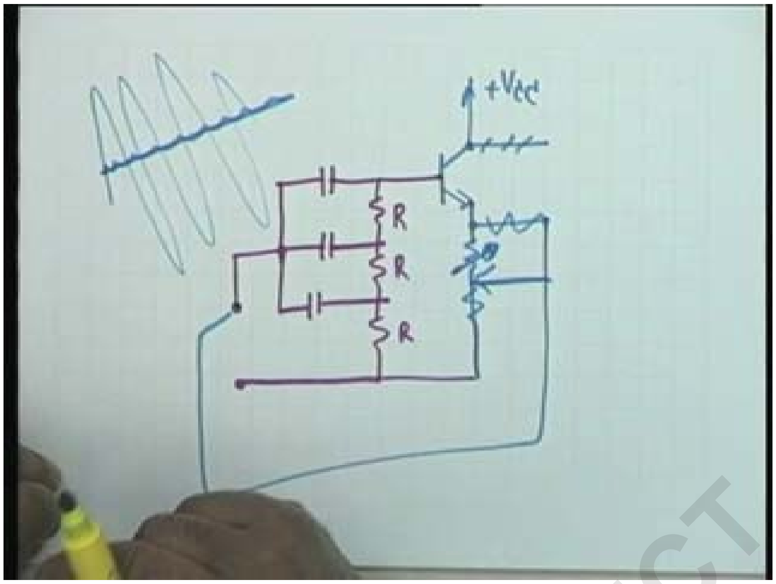

now let’s look at this network [Noise] let's look at this network and let’s say let's call this as ah okay let me draw draw the network like this

R R R this is where i am taking my output R R R and then i have [Noise] C C another C

< a_side > ((input from p one)) (00:50:08) < a_side >

um

<a_side> input from p one <a_side>

input from here

<a_side> from where sir <a_side>

<a_side> here sir <a_side>

from here okay between these two points RC RC RC fine and therefore if i put an input here this output at this frequency root six by CR shall be slightly greater than one and the phase shift will be zero okay

suppose now i connect an active device like this with proper bias in circuits

i connect a ((bjt)) (00:50:46) which is {em} (00:50:51) emitter follower this goes to plus V CC okay

now you know emitter follower has a gain not real to take the output from here emitter follower as you know has a gain very nearly unity but slightly less than unity slightly less than unity isn’t it right

what is the phase shift

<a_side> zero < a_side>

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zero

so the total phase shift from here to here is zero zero plus zero is zero

and a gain can be adjusted to be exactly equal to one because this is slightly less than one this is slightly greater than one in other words if i connect this point to this point okay it should act as an oscillator

this is the second use of the phase shifting network

uses only one transistor one transistor which has a gain greater than less than unity okay does that make this a passive device [Noise] no it is still an active device why

an emitter follower [Noise] although it cannot give a voltage gain it can give

<a_side> current gain <a_side>

current gain

so it gives power gain which means that it can supply energy and this is how an oscillator is obtained

question

< a_side > how can we adjust the gain < a_side>

how can you adjust the gain well i can adjust the gain [Laughter]

< a_side > ((in the ah)) (00:52:28) < a_side >

yeah i can adjust the gain here

infact i can adjust the gain like this [Noise] let me make a connection here okay and this is a potentiometer i can tune the potentiometer to get oscillation and there are this these are very um inspiring experiences

if you if you connect this network in the laboratory and you adjust the gain there is nothing in the oscilloscope you connect the output to be ((oscillo)) (00:52:58) there is nothing will be oscilloscope there is some noise where the condition of oscillation is not met

when it is met suddenly the this on the screen and other wise straight line which is the electron beam suddenly breaks up into oscillation suddenly its breaks up in it it's an exhilarating experience i i wish wish you do where this up this one and the other one the phase shift oscillator i am sure there will be a experiment on oscillation okay

<a_side> (( )) (00:53:32) in that case there will loses but the phase shift will be zero but we can uh < a_side>

okay

no there is the correct as going to ask you why not use a potential (( )) (00:53:46)

<a_side > because here also we are using (( )) (00:53:47) < a_side>

yeah that there is a device which can supply energy whereas

< a_side > profit and loss due to potential (( )) (00:53:54) < a_side>

yes {ene} (00:53:58) definitely energy loss there is no element here to a supply energy

< a_side > (( )) (00:54:03) < a_side >

if it is simply a potentiometer you need an active device for oscillations [Noise] there must be a device which converts DC energy into energy of the oscillations that is a must for oscillations

we will start from here next class

[Noise]

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