

Hello and welcome.

Unit 1 circuit analysis.

Module name star and Delta Networks, and their interconversion.

Module #4 presented by Mr

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Outline.

Start connection and Delta

connection. Interconversion between

star and Delta Connections.

Learning outcomes. The student will be able to explain Star and

Delta connections. And convert from star to Delta connection

and Delta to star connection.

What are star networks?

Look at the figure. Here we have three resistors  $R_A$   $R_B$   $R_C$  connected in this particular fashion. This is known as Star Connection.

You see that one end of all of them are connected at one common point. If you go to the three phase circuits, this is called

as neutral point anyway, will not go into details of that

right now. This is also called a T Network. If you just

open up these two arms. Perpendicular to  $R_C$  will get a

T. Similarly, if you open these two arms for pending, Barbie

will get T network. So this is also called Azure T Network.

Delta networks, if three resistors or more than three

resistors are connected in this

particular fashion. Then we see it is a. We observed that it is

a Delta connection.

OK, so we have a star connection and we have a Delta connection.

Often while analyzing the circuit, we need to change

from star to Delta and Delta to star because that

simplifies our analysis. So How to go about that? Let us

first see Delta to star conversion.

Electrically two circuits will be equivalent if the resistance

between two points two same points are equivalent.

Let's look at this.

If you have a Delta network as shown here, the resistance

between A&B is  $R_{AB}$ .

And also we have  $R_{CA}$  in  $R_{BC}$ . They are in series with one

another and therefore the total resistance between A&B is  $R_{AB}$

parallel to  $R_{CA}$  plus  $R_{BC}$ .

And we know very well when two resistors are in parallel, the

equivalent resistance is given by  $\frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$ . Our equivalent is equal to  $\frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$  or  $R_{\text{equivalent}}$  is given by  $\frac{R_1 * R_2}{R_1 + R_2}$

the same formula we are using

here and we can see there the equivalent resistance between

terminals A&B  $R_{AB}$  and it is this multiplied by the other

register. It is  $R_{BC}$  plus  $R_{CA}$  divided by  $R_1$  plus  $R_2$ . So  $R_{AB}$

plus. You see, plus I see.

Look at this if I want to find in Star how much is the

resistance between nodes A&B or terminals A&B? We can see that

there is a  $R_A$ , and  $R_B$ .  $R_C$  does not come into picture here and

therefore the resistance between A&B is  $R_A$  plus  $R_B$

And now we can equate the two sides. See the previous slide

in Delta we have this equation in Star we have this equation

and therefore  $R_A$  plus  $R_B$  is equal to  $R_{AB}$  into  $R_{BC}$  plus  $R_{CA}$

divided by  $R_{AB}$  plus  $R_{BC}$  plus  $R_{CA}$ .

Similarly, we continue doing the same thing for

our for terminals, B&C, and for terminals C&A.

So if you go back to Delta Between B&C, we have  $R_{BC}$ .

Parallel two  $R_{CA}$  plus  $R_{AB}$ .

And that is exactly what we are getting here. We  $R_{BC}$  parallel

to  $R_{CA}$  plus  $R_{AB}$ . So first into second upon first plus second  $\frac{R_1 * R_2}{R_1 + R_2}$

. And in star between B&C, We have RB and RC and therefore equating we should get this if the two circuits are to be equivalent. Similarly, between Terminal C & A we will have this particular equation because between C & A we have RA and RC. Whereas in case of Delta you can see between C & A will have RCA on one side and RBC and RAB in series on the other side and therefore the resistances RCA into RAB plus RBC divided by RAB plus RBC plus RCA. So note that this equation is 1, two and three.

Now we are given this particular Delta network and we are supposed to find this particular RA, RB, RC. For that we proceed as follows. What we will do, we will subtract this equation to from equation one. Concentrate On the left hand side equation one is RA plus RB, equation 2 is RB plus RC. So if you subtract these terms of the left hand side from this left hand side, RB will get cancelled. And RA minus RC will remain.

Now that we will add to equation #3 so that minus RCN plus are similar tension two RA will remain. This will happen on the left hand side. Similarly we have to do on the right hand side. So this is what we have shown here subtracting equation to from one and adding the result to

three we get  $R_A$ . Of course it was  $t_2 R_A$  but when you come

on this side you get  $R_A$  is equal to  $R_B R_C / (R_{AB} + R_B + R_C)$  .)

Similarly, if we proceed for adding equation, subtracting

equation 3 from 2 and adding it to 1 will get  $R_B$  is equal

to  $R_B R_C / (R_{AB} + R_B + R_C)$  and for the remaining

combination will get the value of  $R_C$  which is  $R_C R_B / (R_{AB} + R_B + R_C)$  .)

So equation number 4, 5 and 6

These are the formula for Delta To star transformation.

You can very easily remember this. Note you can note that

this is  $R_A$ , so which two resistors will come in the top

here? Which has  $R_{AB}$  &  $R_C$  will be there and all the combination

will be important. Similarly for  $R_B$  you can  $R_C$  and  $R_{AB}$ .

Similarly for  $R_C$  will have  $R_B$  &  $R_{AB}$ , so that term will come on the

top and the denominator for all three terms. So you can very

easily remember this equations. Let us see how to go from star

to Delta conversion.

Now you have to sit with your paper and pencil. See that these

equations 4, 5, and 6 .We're playing with this

equations now for our benefit, where I have reproduced the

equations here on the right handside 4, 5 and 6 what

we do, we multiply 4 and 5, 5 and 6 equation 6 and 7.

Sorry 6 and 4r and then add

them together. So just see here. I'll show one example,

4 and 5. If you multiply is RA into RB, let's

hear is equal to this. Multiply by this so  $\frac{RABRCA}{(RAB + RBC + RCA)}$

multiply by  $\frac{RBC RAB}{(RAB + RBC + RCA)}$

so denominators are common so we

have the square of them and look at the numerator. Here

RAB comes twice so we get  $R^2 AB^2 RBC RCA$  divided

by this. So that is what we get RARB if we multiply

equation four and five.

If we multiply 5 and six, we get RBRC and now RBC term will be

squared exactly or procedures similar. Just multiply these two

sides and we're going to get dressed. All remain the same

denominator remains the same, only BCCRBR series are in the

Star, and RA BRB these other assistance in the days are so

whenever we see that DC component get square so it is

easy to remember when we multiply equation for four and

six we get RCRA. This is RC. This

is RA. Adamant about these two will get RCA Square, and now

these have to be added together so RABRARBRBRCRCRA has to be

multiplied. Edit Together so when we add them together, left

hand side becomes like this and the right hand side is this CRA

$B^2 R BCRCRABRB$  squared  $CARABRBCRC$  squared divided by this. Now you can see that we can take our  $ABR BC RCA$  common from these three terms.

And what remains is  $RAB$  from here,  $RBC$  from the second term,  $RCA$  from the third term. And now you can see that this one term here will get canceled with one of the terms here and what remains is this? So? Our  $ABR VCR$  set divided by  $RAB$  plus  $RBC$  this is equation #7. Now this equation 7 has to be divided by equation #4 what happens then? See dividing equation 7 by 4 what we work out?

And what we get is  $RBC$  is equal to  $RB$  plus  $RC$  plus  $RBRC$  by  $RA$  or  $RBCS$ .  $RAR B + R BRC$  plus our  $CRA$  by  $ARI$ . I prefer this because it is very simple to remember because we have our  $BC$  we have  $RBRC$  plus multiplication of these two divided by the third one which is not here. Similarly dividing equation 7 by 5 we get  $RCA$  is  $RA$  plus  $RC$  plus  $RC$  by  $RV$ .

And dividing equation 7 by 6 will have  $RA$  be as easy to remember. We are a plus  $RB$  plus  $RAR$  be divided by the 3rd register  $RC$ . So it is easy to remember start to Delta.

Let us look at an example. We have a star network given here.

For ease. I have taken all these three races to be equal and then

how to find Delta. We know the formula  $RABRA + RV + RAR$

by RC. So  $1 + 1 + 1$  into  $1$  by  $1$ , so we get three and similarly

will there be C&C and therefore the star network given like this

will be converted to Delta Network as shown in this figure.

Similarly, let us go for Delta to star. Suppose it Delta

network is given like this are a B1 home RBC, One Oman RCA tool.

Then putting in the formula that we have just now calculated we

get points for CRA are see we can see that RA is there are a

BRCA upon Rab plus RBC plus how to say so? Rab is 1 RCA is 2 so

$1$  into  $2 / 1 + 1 + 2$  so  $2$  by  $4.5$  similarly RB we get  $.25$

RCM at  $.5$ .

So this star Delta Network is getting converted into

Star Network. OK, so this is how we can convert from

star Delta Network to star references as shown here.

Thank you.