

Quadrant II - Transcript

Program SY BSc, subject Physics, Semester 3, paper code P YS101, paper title Network analysis. A warm Welcome to all. I'm Nirupa Nayak, Assistant professor, Government College of Arts, Science and Commerce, Quepem, Goa. I'll be discussing module number 10, Superposition Theorem, from unit 2, Circuit analysis and network theorems.

In this module we are going to learn the concept of Superposition theorem and will be solving problem based on that. After learning this module student will be able to understand the concept of superposition theorem. Superposition theorem.

Statement: superposition theorem states that in any linear network containing two or more sources, current flowing through any element is the algebraic sum of the currents flowing through that element considering one source at a time and replacing other sources with their internal resistances. Let us consider this example. There are two sources. OK, if the current flowing through 10 ohm resistor due to the 10 Volt source or source 1 is I_1 when we are replacing the source 2 by its internal resistance and similarly if I_2 is the current flowing through this 10 ohm resistor when we are considering source 2, this current source and replacing the source 1 with its internal resistance. Then according to superposition theorem, when both the sources are there, the current flowing through the 10 ohm resistor is the algebraic sum of the current considering one source at a time. That is, I_1 plus or minus I_2 . OK let us apply the superposition theorem and try to calculate the current flowing through 15 ohm resistor. So we have to consider one source at a time and try to calculate the current flowing through this 15 ohm resistor. Consider source 1 which is a voltage source E equal to 10 Volt. We have to remove the current source, I equal to 5 amps and replace it with its internal resistance. We know that the internal resistance of a constant current source is infinite, or it is represented as open circuit. So it has been shown here. We have removed the current source and kept the terminal open. OK. Now here we have to calculate the current flowing through this 15 ohm resistor due to the source, the first source that is 10 volt. See here as this is kept open OK, no current will flow in this branch. OK as it is very high impedance or infinite, impedance so no current will flow in this direction and all of the input current will be flowing through this 15 ohm

resistor. Therefore, the current flowing through 15 ohm resistor due to the first source is I_1 , that is equal to that the incoming current I only that's equal to applying ohms law. We can write $10 / (10 + 15)$ that's equal to $10 / 25$. That's equal to $2 / 5$ ampere which flows from A To B. Now we have to calculate the current flowing through the same 15 ohm resistor due to the current source. So consider the source 2 which is our current source, then remove the voltage source E is equal to 10 volt and replace it with its internal resistance. We know that the internal resistance of a voltage source is 0 or it is represented as a short circuit. So that has been done here. We have removed the voltage source and we have short circuited these two terminals. Now we have to calculate what is the current flowing through this 15 ohm resistor, due to this current source of 5 ampere? From the circuit we can see here the input current is dividing into two branches. So in order to find out the current flowing through 15 ohm resistor I have to apply the current divider method. According to current divider method the current I_1 is equal to total input current. That is, I into the resistance of the other branch, into 10 divided by some of the resistances, that is $10 + 15$. That gives me $(5 \text{ into } 10) / 25$ that is also equal to 2 ampere which flows from A to B. So in both the cases, because of the both the sources the current was flowing from A to B. OK, therefore the current flowing through 15 ohm resistor due to both the sources is, I_{15} is equal to I_1 plus I_2 as I said because of both the sources the current is flowing from A to B only so I have to add those two currents. That is equal to $2 / 5$ plus 2 that's equal to $(2 + 10) / 5$. That is also equal to $12 / 5$ ampere which flows from A to B.

Let us consider one more example. Example 2: determine the voltage across 20 ohm resistance in the circuit shown, using superposition theorem. We know that we have to apply superposition theorem. We have to consider one source at a time and try to calculate the current flowing through that particular 20 ohm resistor. Consider voltage source S_1 . OK. Remove the sources S_2 and S_3 and replace them with their internal resistances. The source S_2 is a current source so I have to keep that open here. That has been done here and source S_3 is a voltage source and I know I have to represent it by a short, so that has been done here. Now I have to calculate the current flowing through 20 ohm resistor due to source S_1 which is I_1 OK. This gives me a closed path. By applying ohm's law I can calculate the current flowing

through the 20 ohm resistor due to source S1. That is given as I_1 is equal to $40 / (20 + 80)$, that is $40 / 100$. that is equal to 0.4 ampere and the current is flowing from A to B. So now consider the current source S2. Remove the sources S1 and S3 and replace them with their internal resistances. So I have to replace the sources S1 and S3 by their internal resistance as both of them are voltage sources. I have to just short the terminals that has been done here. It is shorted here. As well as shorted here. Now I want to calculate what is the current flowing through this 20 ohm resistor due to source S2? Here 1 ampere current is dividing into two branches. So according to current divider OK, I can calculate the current I_2 . OK that is given as I_2 is equal to the total input current that is 1 ampere into resistance of the other branch that is 80 divided by (20 plus 80). OK, that is equal to $80 / 100$. That gives me 0.8 ampere which flows from A to B. OK, here I_2 is also flowing from A to B. Again we have to consider the source S3 and we have to replace the sources S1 and S2 by their internal resistances. Now consider here, the source S1 is a voltage source, so it has been removed and replaced by its internal resistance. That is I have to short the terminals and Source S2 is a current source, so I have to keep it open. That has been done here. Now I want to calculate what is the current flowing through this 20 ohm resistor due to source S3? That is represented as I_3 . OK, so from the circuit we can see that the current flowing through 20 ohm resistor due to S3 is ; I_3 is equal to $30 / (20 + 80)$ that's equal to $30 / 100$ is equal to 0.3 amps, which flows from B to A. Now we can see that the current I_3 is flowing from B to A, whereas both the currents I_1 and I_2 were flowing from A to B. Now according to superposition theorem I have to do the algebraic sum of the currents considering one source at a time. So we have the current flowing through this 20 ohm given as $I_1 + I_2$ because both the currents I_1 and I_2 were in the same direction, whereas I_3 was in opposite direction. So I have to write I_1 plus I_2 minus I_3 is the total current flowing through this 20 ohm resistor due to all the sources. That is equal to $0.4 + 0.8 - 0.3$. That gives me 0.9 ampere which flows from A to B. Therefore voltage across the 20 ohm resistor is we are asked to find out, what is the voltage across this 20 ohm resistor? When I know the total current flowing through that resistor and the resistance value, I can calculate voltage which is nothing but I into R

that is equal to 0.9×20 . That gives me 1.8 volts.

So in this module we learnt how to apply Superposition theorem for circuit analysis.

These are the reference books. Thank you.