Program: FY BSc, Subject: Physics,

Semester one, Paper code:

PYC 101, Paper title: Mathematical

methods and Mechanics and Electrical

circuit Theory( Section 2), Section

2: Electrical circuit theory.

Unit One: Circuit analysis

Module name: Norton’s theorem

Part 2. Module number 10.

Outline of this module:

Norton's theorem:1) problem solving,

2) concept of source transformation.

Learning outcome: the student will be

able to convert the given 2 terminal

network into its Norton's equivalent.

2) Use source transformation

technique in circuit simplification.

OK, in this module we are going to solve

some more problems on Norton’s theorem OK.

Consider example 3: calculate the

current flowing through RL is equal

to 6 ohm using Norton's theorem.

So we are asked to find out the

current flowing through RL is equal

to six ohm using Norton's theorem.

For that we have to convert this two

terminal network into Norton's equivalent.

For that we have to find out

IN and then RN.

OK to find IN remove the load

RL is equal to 6 ohm and short

the terminals P and Q. That has been

done here and this short circuit

current is our Norton's current.

Calculate the short circuit current ISC ,

that's equal to IN, which is our

Norton's current.

OK, we can use superposition theorem

here to find out what is the short

circuit current or Norton's current?

OK, consider voltage source E equal to

60 volt. First I'll consider the voltage

source and I remove the current source

and replace it with its internal resistance.

Consider voltage source

E is equal 6 ohm, 60 Volt,

sorry. Remove current source and replace

it with its internal resistance.

OK that is open.

OK So what we have done we have

to remove the current source.

Like this and replace it with

it's.

internal resistance, that

is open circuit here.

OK,

so see from this circuit, we can see

here ,the current from this voltage

source is taking this path and it

will not flow in this path because

it is a resistive path, right?

Whereas it can easily pass through PQ.

So IN 1, that is current due to

the source 1, that is voltage

source is given as E / 10

ohm, that's equal to 60 / 10 .

That's equal to 6 amps,

which flows from P to Q.

Now consider the current source

I is equal to 5 A.

Now I'm considering this.

I'm replacing this with

its internal resistance.

Remove the voltage source E and replace

it with its internal resistance.

That is short circuit so

that has been done here.

I have removed the voltage source

and I have shorted the terminals.

Now look at this one here.

The current from the current

source OK will take this path.

It will straight away go like

this and close the circuit

like it will flow like this,

and complete the circuit circuit like this.

It will not go into 15 ohm resistor

as well as 10 ohm resistor, because

this is an easier path for it.

OK from the circuit IN 2 is

equal to 5 amp which is nothing

but the source current right?

Because current will not flow

into resistors 15 ohm or 10 ohm.

It will take an easier path through PQ short.

OK now  the current flowing,

now I want I SC that is  Norton's

current, that is nothing but current due to

both the sources. OK, therefore,

IN is equal to IN1

plus IN2. Because in both the cases,

current IN1 is also flowing from P to

Q Whereas IN2 is also flowing from P to Q.

So we have to add IN1 and

IN2, that's equal to 6 amps

plus 5 amps  is equal to 11 amps.

So we got Norton's current IN as 11 ampere.

To find RN what we have to do?

Remove the load and replace the

source with its internal resistance.

That is short for voltage source

and open for current source.

Right calculate the equivalent

resistance RN between P&Q.

What we have to do we have to

remove RL and replace the sources

with their internal resistances.

Voltage sources being replaced by short

OK and current source is kept open.

OK like this and what is RN? RN is the

equivalent resistance between the terminals,

P&Q right? From the circuit

we can say this is nothing,

but it's a parallel combination

of 10 ohm and 15ohm.

Right? Therefore RN is parallel

combination of 10 ohm and 15 ohm. Therefore

RN is equal to 10 parallel

with 15 that's equal to (10 x 15)

/ (10 + 15), is equal to 150 by 25.

That's equal to 6 ohm.

So we got RN as 6 ohm.

Therefore,

Norton’s equivalent Circuit becomes like this,

with IN is equal to 11 amps and RN is equal to 6 ohm.

Therefore we have connected

RL is equal to 6 ohm like this.

OK,

now we have to calculate the current

IL right? The general equation

for Norton's current,

the load current IL is, IL is equal

to (IN x RN)/( RN + RL).

OK,  therefore, that's equal

to (11x 6) / (6 + 6) that's

equal to 66 by 12.

That is 11 by 2 or that's

also equal to 5.5 amps.

So we have calculated the

current flowing through RL is

equal to 6 ohm using Norton's theorem.

OK, let us know something about source

transformation. OK . What is source transformation?

It is nothing but converting,

Norton’s equivalent into Thevenin’s equivalent and vice versa.

OK so here we are going to convert

Thevenin’s equivalent into Norton's equivalent.

OK, we know that Thevenin’s equivalent

is written like this. Right? Vth

in series with a resistance R th.

Now I'm considering this Thevenin’s

equivalent as a 2 terminal network.

And I'm going to find out the Norton's

equivalent for this particular circuit, OK?

To find IN, what I have to do?

I have two short the terminals A&B

and find out the short circuit current

ISC is equal to IN. Right ? From the

circuit diagram we can straightaway

say that IN is equal to Vth

divided by Rth , right?

So we got IN as Vth by Rth.

To find RN, what we have to do? We

have to remove the source and replace

it with its internal resistance.

So I have removed the voltage source

Vth and have shorted it.

So what is the equivalent resistance

between A&B?

That is nothing but Rth.

So from the circuit we have RN

is equal to Rth OK?

Therefore, Norton's equivalent of

Thevenin circuit is given  like this.

Where IN  is equal to Vth by

Rth, and RN is equal to Rth.

OK, So what we can say is the thevenin's

equivalent is nothing but a voltage source,

right?

And Norton’s equivalent is nothing

but a current source.

So I'm converting a voltage source into

a current source, or I can even convert

a current source into voltage source,

OK?

Similarly,

Norton’s equivalent can be converted

into thevenin's equivalent like this.

Where Vth will be INx RN

and Rth will be equal to RN.

OK this is called,

this technique is called

source transformation.

OK, using source transformation technique

we can easily solve problem 3.

OK, we have done problem 3 already.

I will show how easily we can solve this

problem 3 using source transformation.

OK now I'm going to replace

this voltage source.

It looks like Thevenin’s equivalent right?

This voltage source into current source.

So I've shown here, the current

source becomes with current source

of 6 amps in parallel with 10 ohm.

OK, I replace this voltage

source with this current source.

OK, so the circuit will become like

this replacing voltage source by

current source in the main circuit.

We have like this.

This circuit we will get. So we know that

when current sources are in parallel

we can add or subtract depending on

the direction of the current right?

So we have two current sources here in

the same direction so I have to add it.

OK so the total current will

be like this , 6 amps,

ok, this after adding it will be 11 amps.

Because I have to add 6 amps plus

5 amp, so it is 11 amp. Similarly.

I have got two resistances in parallel,

not RL.

This 10 ohm and 15 ohm,

which are in parallel.

Therefore the equivalent resistance of 10.

ohm and 15 ohm gives me 6 ohm.

So I can represent that as

RP and write it like this,

6 ohm right?

So I have simplified this

circuit like this OK.

Comparing this simplified circuit

with Norton's equivalent, we get OK.

Just see here.

This is nothing but it looks like

Norton's  equivalent, right?

So I can just replace IST + I as IN.

So IN is equal to 11amp and  RP

is equal to RN which is equal

to 6 ohm. So straight away with

the source transformation I got,

Norton's equivalent right?

OK so how to find out IL? That is

similar to the Norton's equivalent.

So I have to write,

(IN xRN) divided by (RN + RL).

Therefore (11 x 6) /

(6 + 6) or 66 / 12 or 11 /2.

That's equal to 5.5 amps.

You can counter check with the

earlier solution that is the same.

So we got the same solution.

OK so we can say that this source

transformation or changing the

source technique can be used

for circuit simplification.

OK, we can easily simplify the circuit.

These are the reference books. OK, thank you.