# ECE 203

## Circuits I

# The Thévenin and Norton Theorems

## Lecture 8-1

# *The Thévenin and Norton Theorems*

- ***Thévenin's theorem*** tells us that we can replace an entire network by an equivalent circuit that contains only ***an independent voltage source in series with a resistor*** in such a way that the current–voltage relationship is unchanged.

- Similarly, ***Norton's theorem*** tells us that we can replace an entire network by an equivalent circuit that contains only ***an independent current source in parallel with a resistor*** in such a way that the current–voltage relationship is unchanged.

# *Léon Charles Thévenin (1857-1926)*

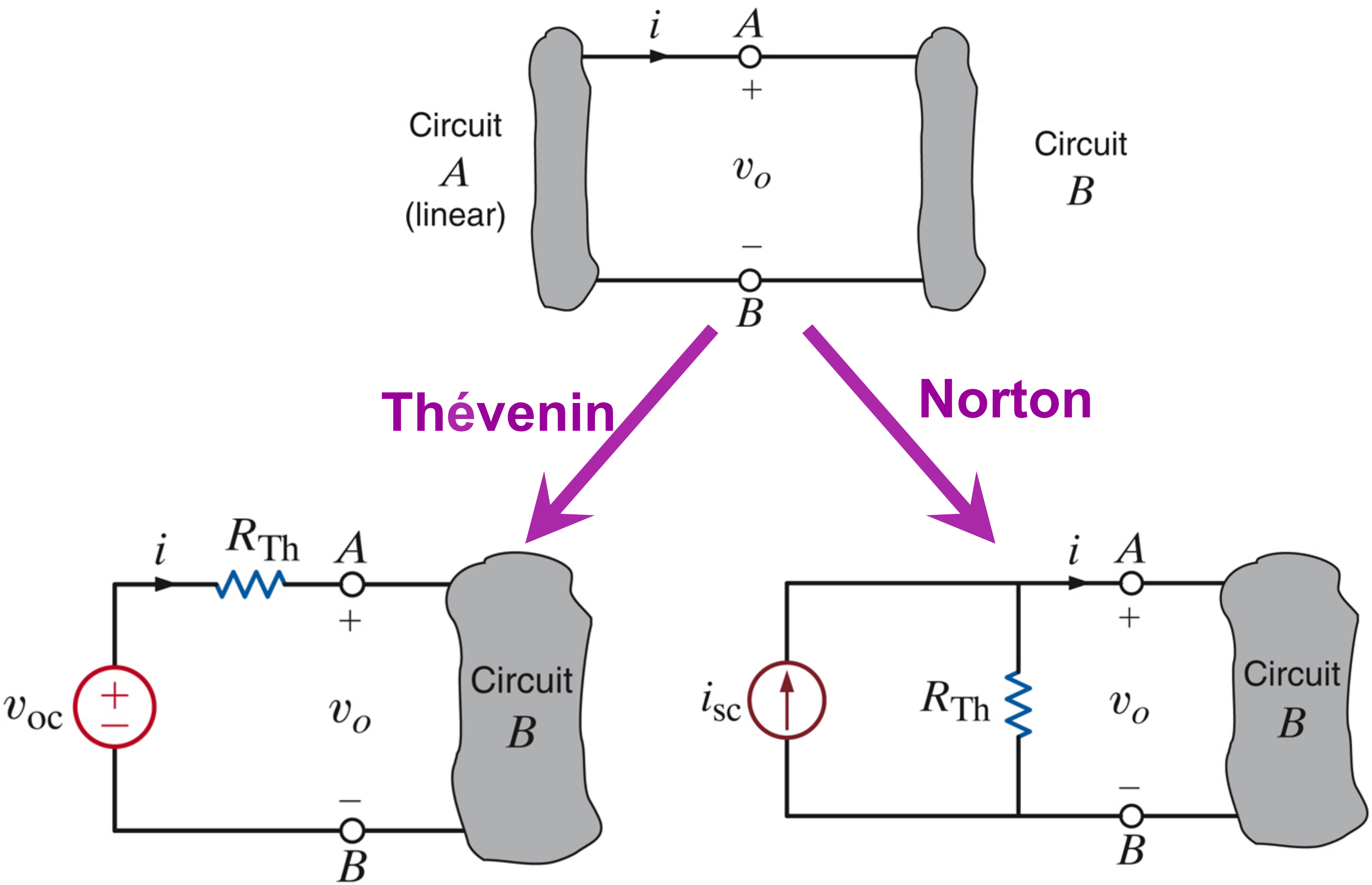
Léon-Charles Thévenin (b.Meaux, France, 30th March 1857, d. Paris, 1926) was a French telegraph engineer and educator. He was the one to propose the equivalent generator theorem in 1883, 43 years before Norton's complementary theorem. The theorem is commonly called Thévenin's Theorem in his honour, but, in fact Hermann Von Helmholtz proposed it first in an 1853 paper. Thévenin graduated from the École Polytechnique in 1876 and became one of the first students to enroll in the École Superieure de Telegraphie (EST) to be prepared for a career in the government owned telegraph service. In the two-year program at the EST, he was introduced to Gustav Kirchhoff's laws of circuit analysis. His duties included administrative and educational activities. Thévenin devoted a considerable portion of his time to teaching, for which he had a liking. In connection with his teaching, he undertook an investigation of Kirchhoff's laws as applied to electric networks. This study resulted in his formulation of the equivalent generator theorem.

# *Edward Lawry Norton (1898-1983)*

Edward Lawry Norton (b. Rockland, Maine, USA, 28th July 1898, d. Chatham, New Jersey, USA, 28th January1983) was an American electrical engineer for whom the Norton equivalent circuit is named. Norton served as a radio operator in the U.S Navy between 1917 and 1919. He attended the University of Maine for one year before and for one year after his wartime service, then transferred to MIT in 1920, receiving his BS degree in electrical engineering in 1922. He started work in 1922 at the Western Electric Corporation in New York City, which eventually became Bell Laboratories in 1925. While working for Western Electric, he earned an MA degree in electrical engineering from Columbia University in 1925.

Among his publications are constant resistance networks with applications to filter groups in the Bell System Technical Journal, magnetic fluxmeter in the Bell Laboratories Record and dynamic measurements on electromagnetic devices in the Transactions of the AIEE. Norton wrote 92 technical memoranda (TMs in Bell Laboratories parlance). Because of Norton's lack of publications, it appears that Norton preferred working behind the scenes. As described in the history of Bell Labs, "this reticence belied his capabilities."

# Thévenin'and Norton Equivalent Circuits



# Applying *Thévenin's Theorem*

1) Break the circuit at the point of interest
2) Calculate the open circuit voltage at the broken point
3) Short voltage sources and open current sources and calculate the Thévenin resistance looking back into the network

# Applying Norton's Theorem

1) Break the circuit at the point of interest
2) Calculate the short circuit current at the broken terminal
3) Short voltage sources and open current sources and calculate the Norton resistance looking back into the network

Note: The Thévenin resistance and the Norton resistance are the same: $R_N = R_{th}$. Often in the Norton equivalent circuit, the resistance is shown as $R_{Th}$.

# Alternate way to calculate $R_{th}$

Find $V_{oc}$

Find $I_{sc}$

$R_{th} = V_{oc}/I_{sc}$

# Examples

Go to Examples 8-1.1 thru 8-1.5