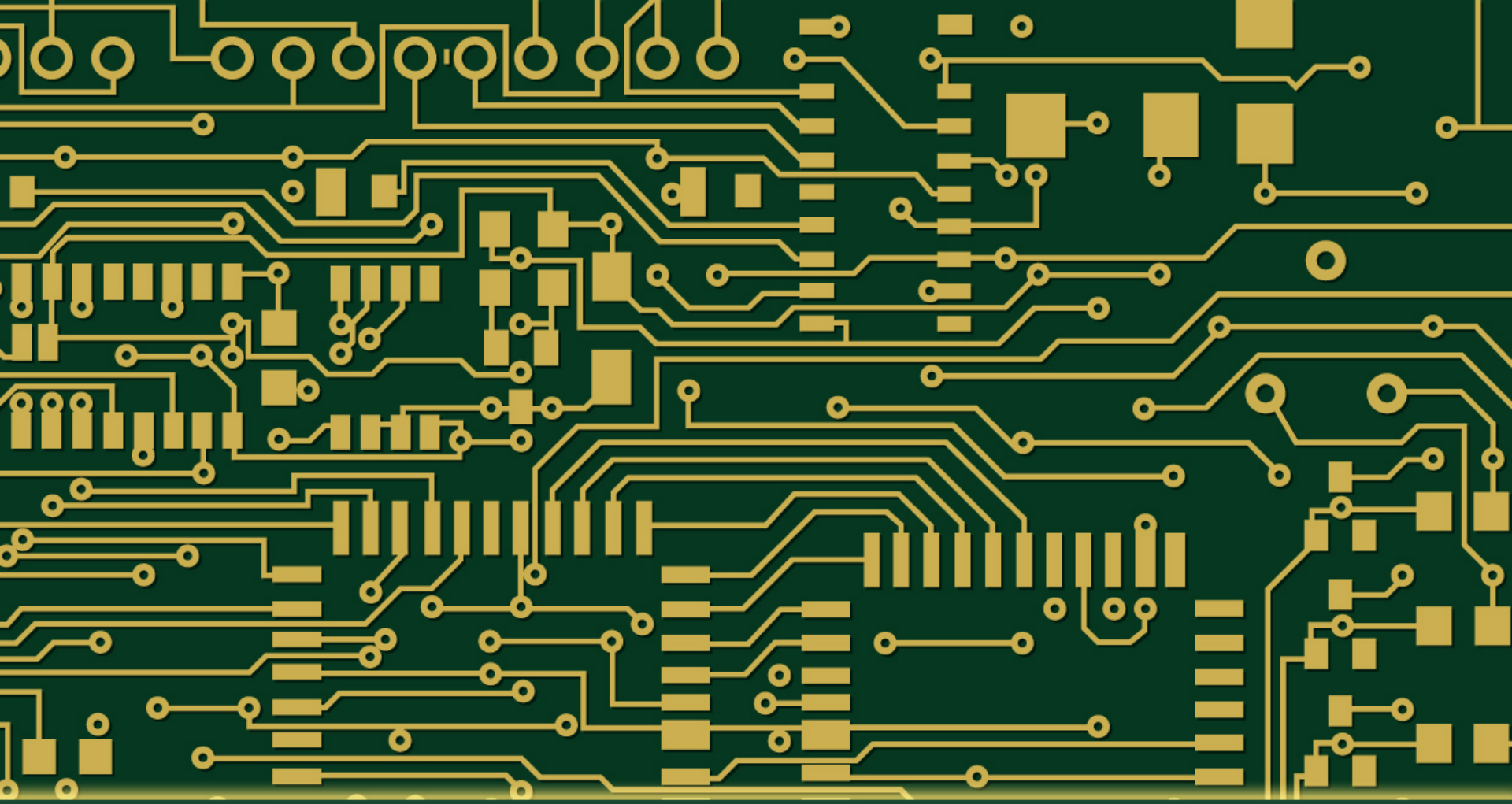
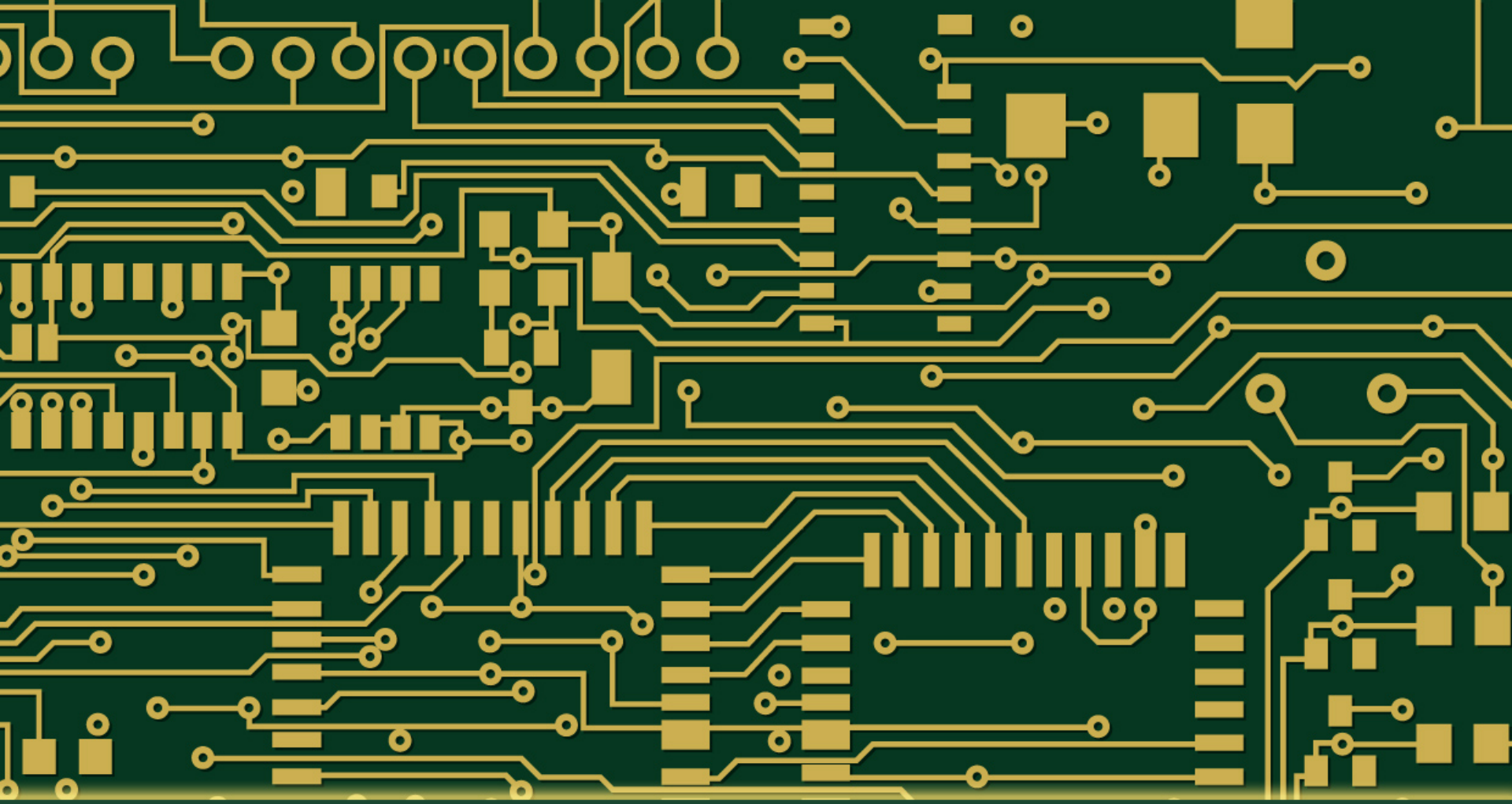


Circuit Analysis-II



The Superposition Theorem

Superposition Theorem

- ✓ The theorem states that:

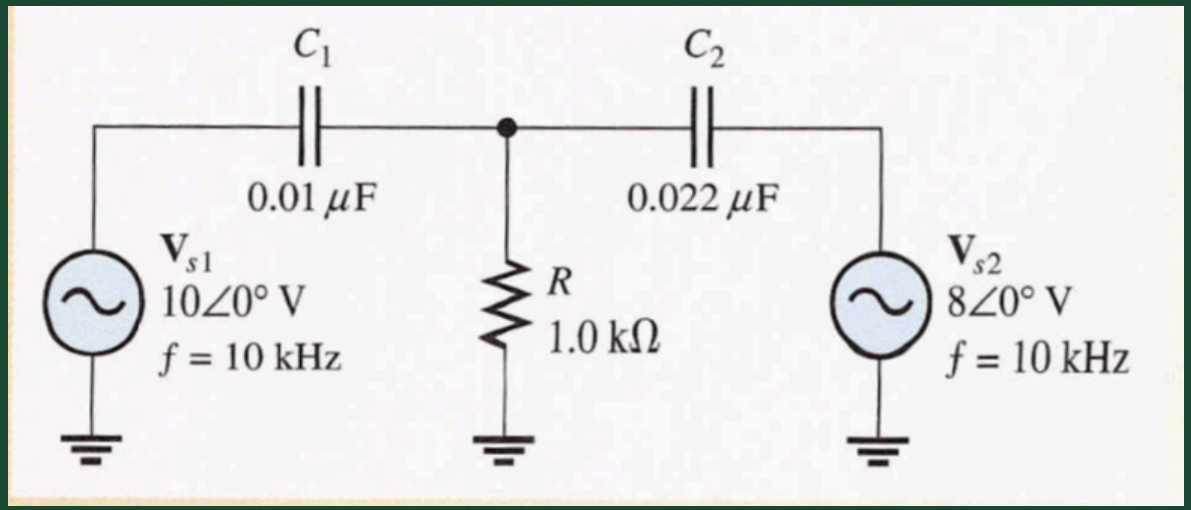
  "The current in any given branch of a multiple-source circuit can be found by determining the currents in that particular branch produced by each source acting alone, with all other sources replaced by their internal impedances. The total current in the given branch is the phasor sum of the individual currents in that branch."

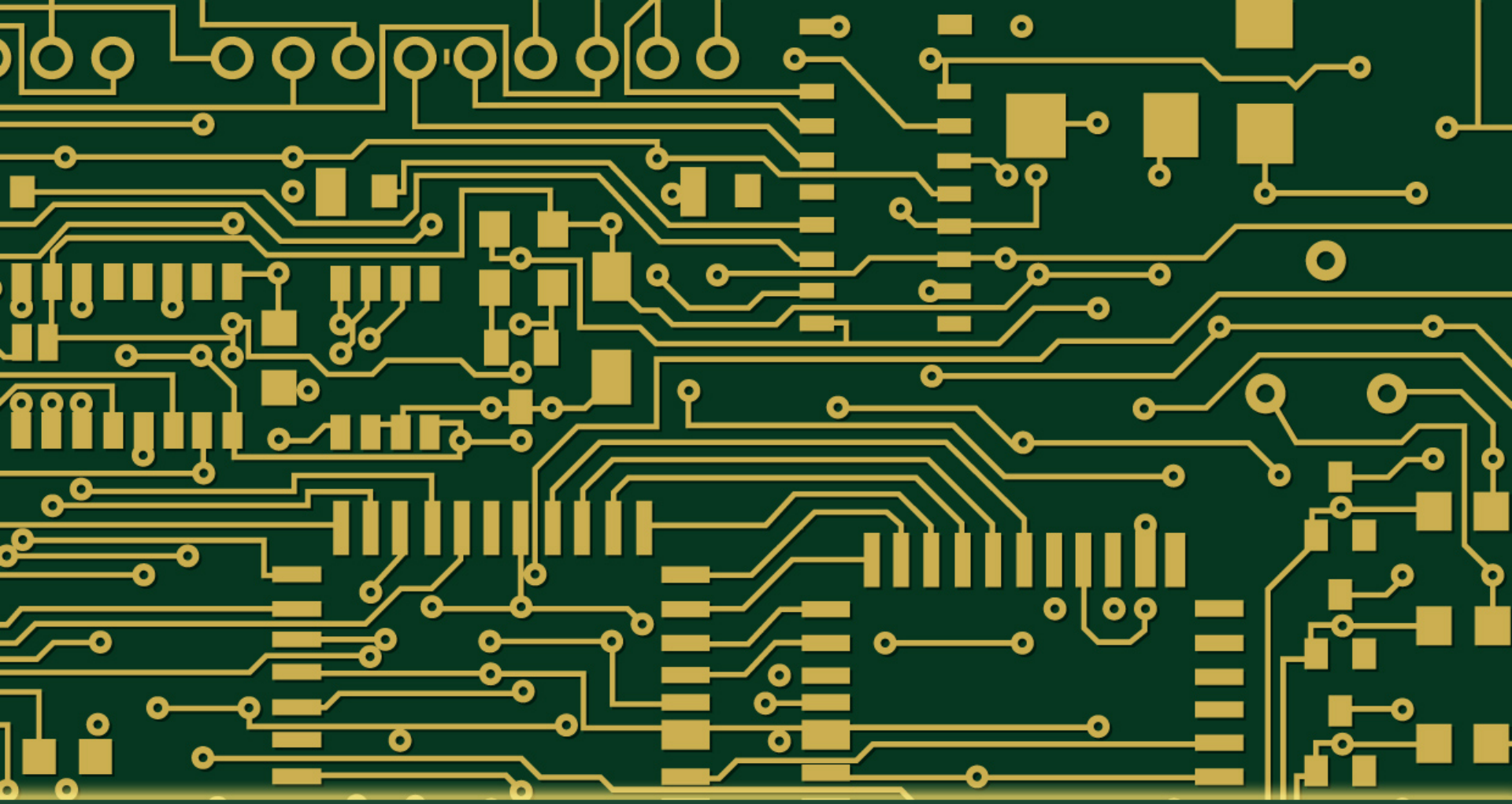
Procedure

- ✓ Step #1: Leave one voltage (current) sources in the circuit, and replace all others with their internal impedance. For ideal voltage sources, the internal impedance is zero. For ideal current sources, the internal impedance is infinite. This is known as zeroing the source.
- ✓ Step #2: Find the current in the branch of interest produced by the one remaining source.
- ✓ Step #3: Repeat steps 1 and 2 for each source in turn. When complete, you will have a number of current values equal to the number of sources in the circuit.
- ✓ Step #4: Add the individual current values as phasor quantities.

Example #1

- ✓ Find the current in R in figure shown below using superposition theorem. Assume the internal source impedances are zero.

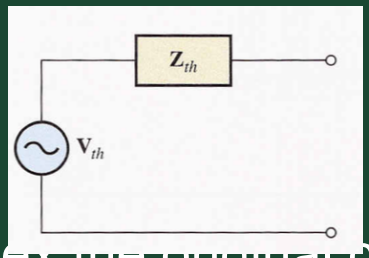




Thevenin's Theorem

Equivalency

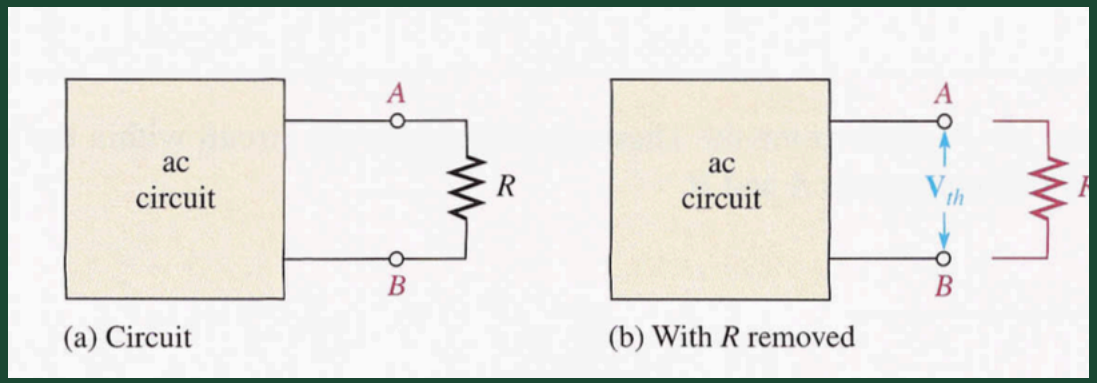
- ✓ The form of Thevenin's equivalent circuit is shown below:



- ✓ Regardless of how complex the original circuit is, it can always be reduced to this equivalent form.
- ✓ The equivalent voltage source is designated $\mathbf{V}_{th}$, the equivalent impedance is designated $\mathbf{Z}_{th}$.
- ✓ By Thevenin's theorem, the circuit in the block can be reduced to an equivalent form.
- ✓ The term equivalent means that when the same values of load is connected to both the original circuit and Thevenin'e equivalent circuit the load voltages and currents are equal for both.

Thevenin Equivalent Voltage (V_{th})

- ✓ Thevenin equivalent voltage is defined as the open circuit voltage between two specified terminals in a circuit.



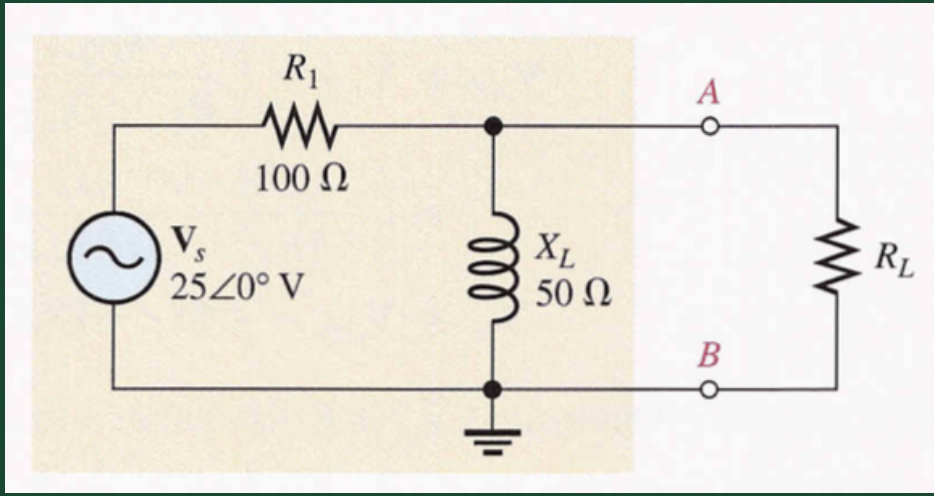
- ✓ Let's assume that an ac circuit of some type has a resistor connected between two specified terminals A and B.
- ✓ To find the Thevenin equivalent circuit for the circuit as "seen" by R.
- ✓ V_{th} is the voltage across terminals A and B with R removed.

Thevenin Equivalent Voltage (V_{th}) (cont.)

- ✓ The circuit is viewed from the open terminals A and B and R is considered external to the circuit for which the Thevenin equivalent is to be found.

Example #2

- ✓ Determine $\mathbf{V}_{th}$ for the circuit within the beige box as viewed from terminals A and B.

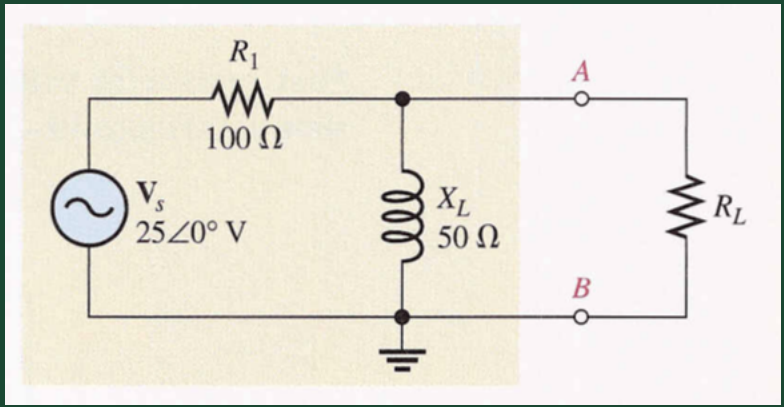


Thevenin Equivalent Impedance (Z_{th})

- ✓ Thevenin equivalent impedance is the total impedance appearing between two specified terminals in a given circuit with all sources replaced by their internal impedances.
- ✓ To find Z_{th} between any two terminals in a circuit, replace all the voltage sources by a short.
- ✓ Replace all the current sources by an open.
- ✓ Then determine the total impedance between the two terminals.

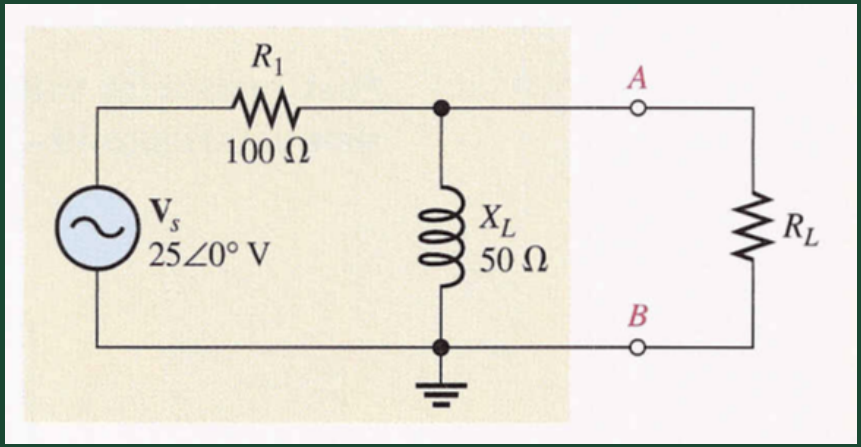
Example #3

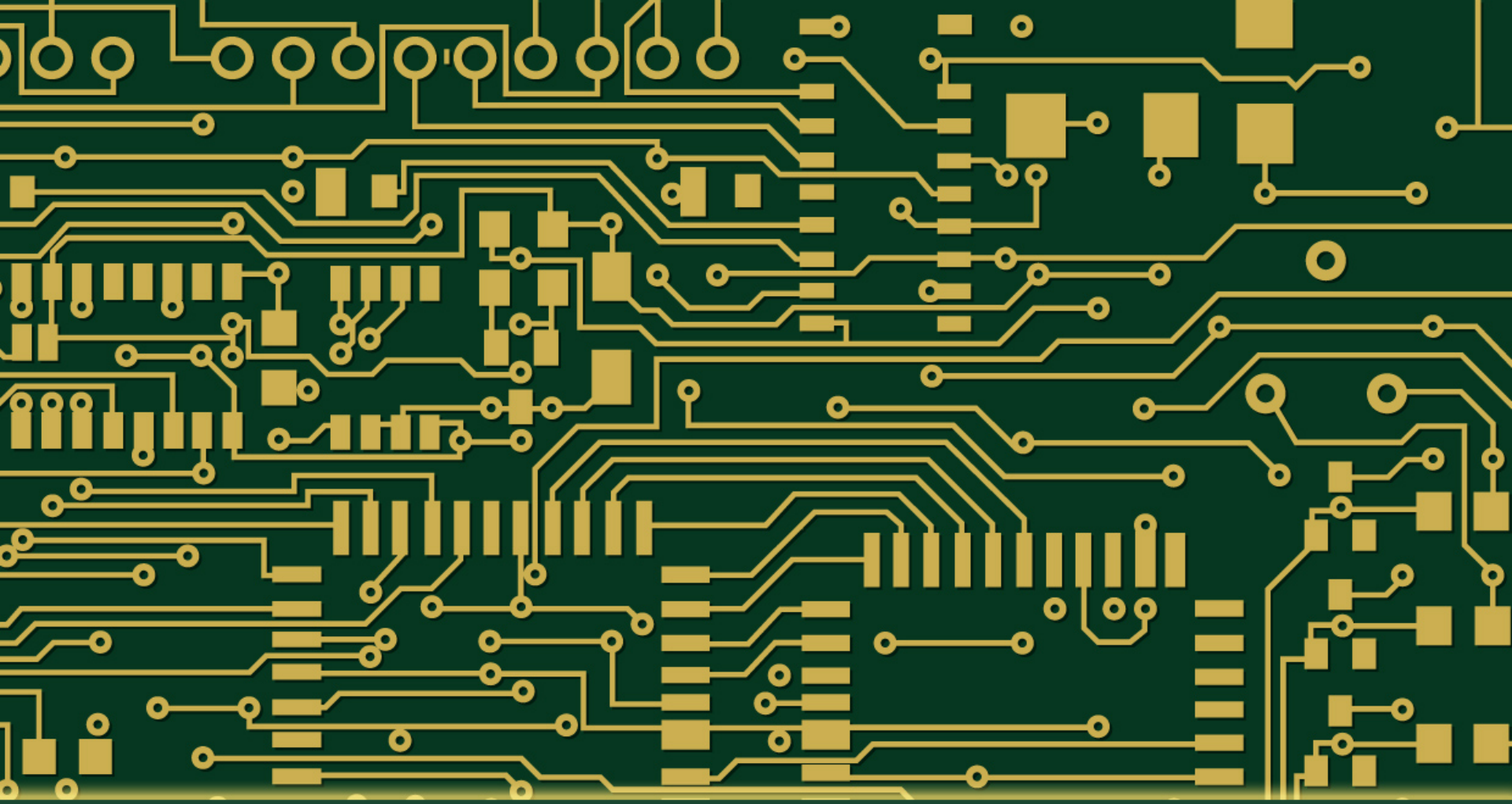
- ✓ Find $\mathbf{Z}_{th}$ for the part of the circuit shown below that is within the beige box as viewed from terminals A and B.



Example #4

- ✓ Draw the Thevenin equivalent for the circuit within the beige box as viewed from terminals A and B.





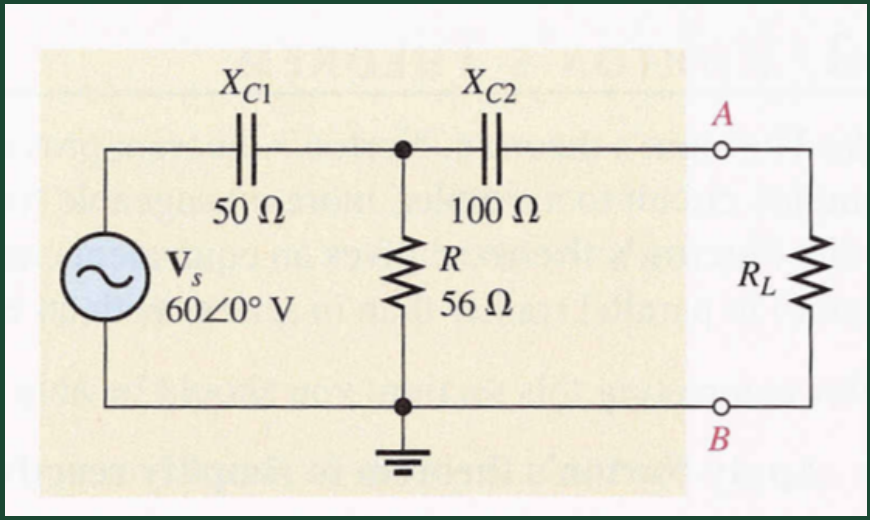
Norton's Theorem

Norton's Equivalent Current Source (I_n)

- ✓ Norton's equivalent current is defined as the short-circuit current between two specified terminals in a given circuit.
- ✓ Any load connected between these two terminals effectively "sees" a current source $\mathbf{I}_n$ in parallel with $\mathbf{Z}_n$.
- ✓ To find $\mathbf{I}_n$ calculate between terminals A and B with those terminals shorted.

Example #5

- ✓ Determine I_n for the circuit as "seen" by the load resistor. The beige area identifies the portion of the circuit to be nortonized.

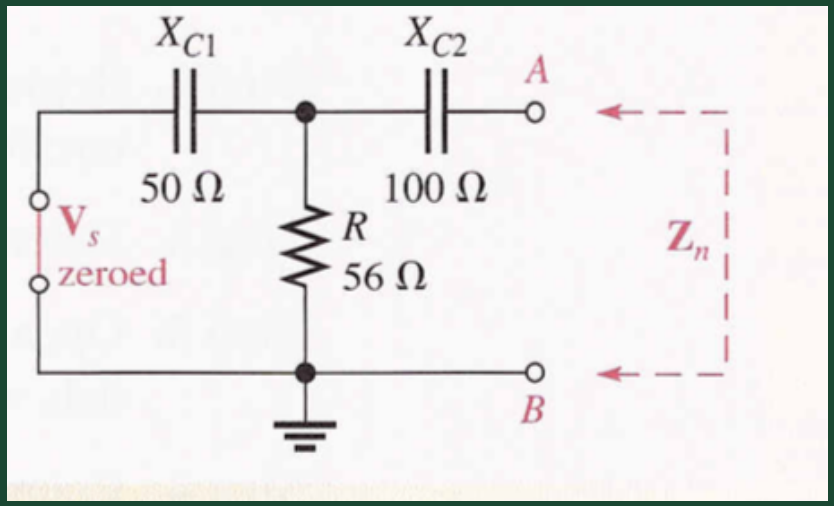


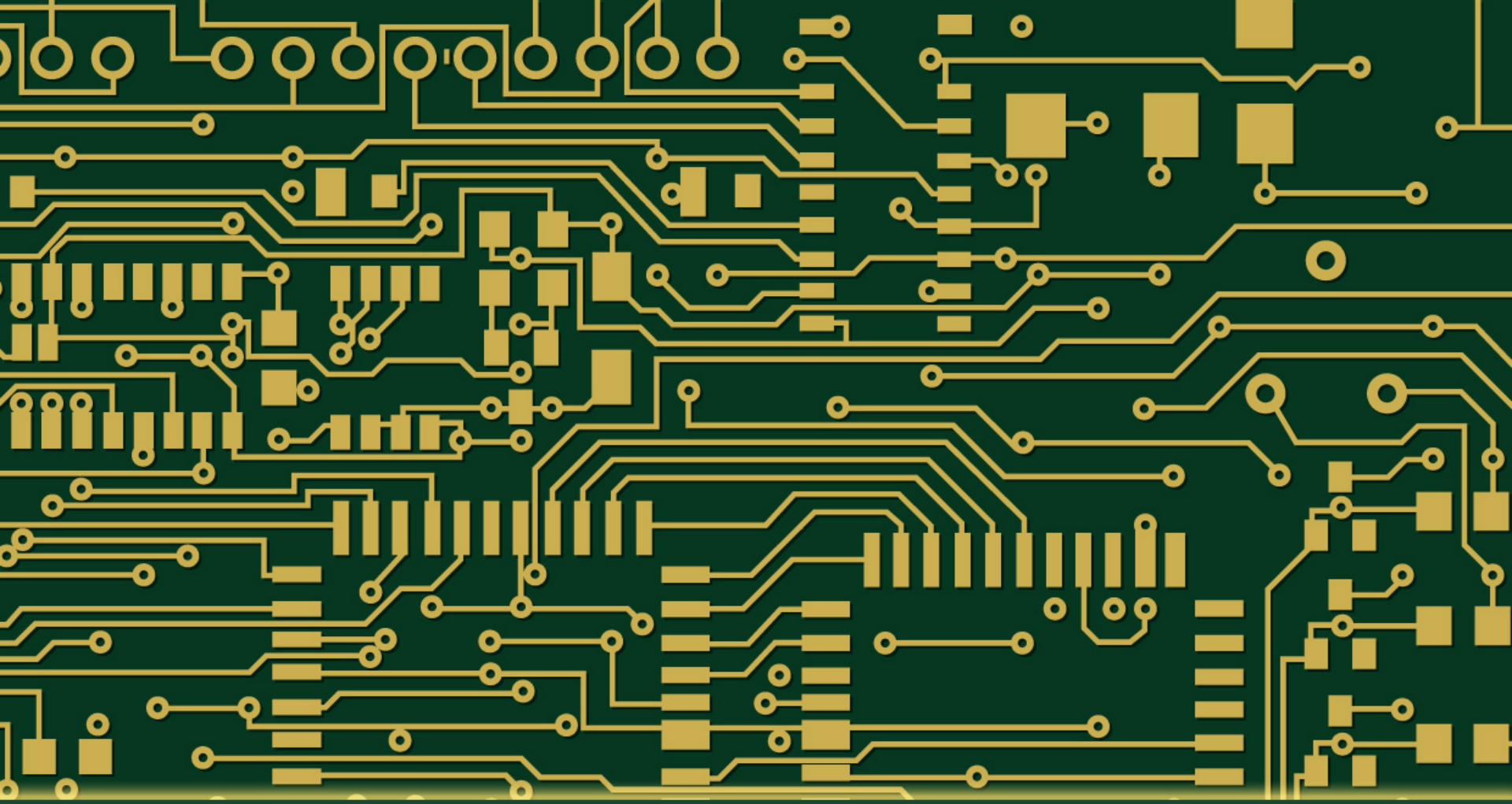
Norton's Equivalent Impedance (Z_n)

- ✓ Z_n is defined the same as Z_{th}.
- ✓ It is the total impedance appearing between two specified terminals of a given circuit viewed from the open terminals with all sources replaced by their internal impedances.

Example #6

- ✓ Find $\mathbf{Z}_n$ for the circuit shown below, viewed from the open across terminals A and B.





Thank You