The above statement is known as "Tellegen's Theorem" and valid in both domains \( t \) and \( s \).

If we have a network consist of only \( R,L,C \) (i.e. bilateral element) then the contribution of all internal branches is zero. If the network has \( L \) and \( C \) also, it is more useful to apply it in the \( s \) domain.

Let \( k = 1 \) represents the branch at port 1 and \( k = b \) represents the branch at port 2. All other branches represents the internal branches. So we have

\[
\sum_{k=1}^{b} (\hat{v}_k i_k - v_k \hat{i}_k) = 0
\]

We Have

\[
\sum_{k=2}^{b-1} (\hat{v}_k i_k - v_k \hat{i}_k) = 0
\]

From now onwards we will represent subscript 1 for port one and subscript 2 for port two and we will apply Tellegen's theorem in the \( s \) domain.

\[
\hat{V}_2(s) I_2(s) = V_1(s) \hat{I}_1(s)
\]

\[
\frac{\hat{I}_1(s)}{\hat{V}_2(s)} = Y_{12}(s) = \frac{I_2(s)}{V_1(s)} = Y_{21}(s)
\]
This is the condition for reciprocal networks.

The resistor is a bilateral element

\[ i(t) \]
\[ v(t) \]

\[ i(t) \]
\[ v(t) \]

Another example of reciprocity.

Using Tellegen’s theorem we have

\[ \frac{I_2}{V_1} = \frac{I_1}{V_2} \]

i.e., if we change the position of the voltage source, the “transfer functions” remain the same.