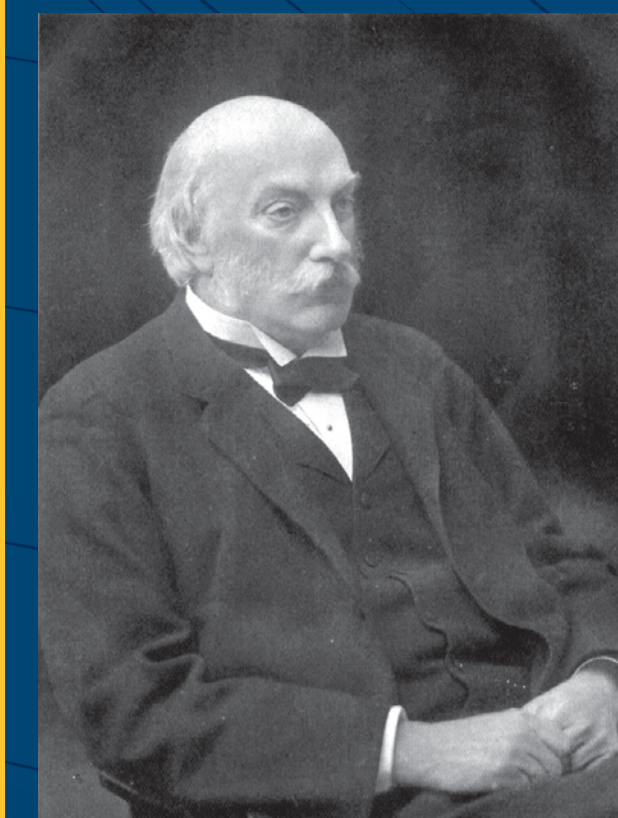


Electromagnetic Reciprocity

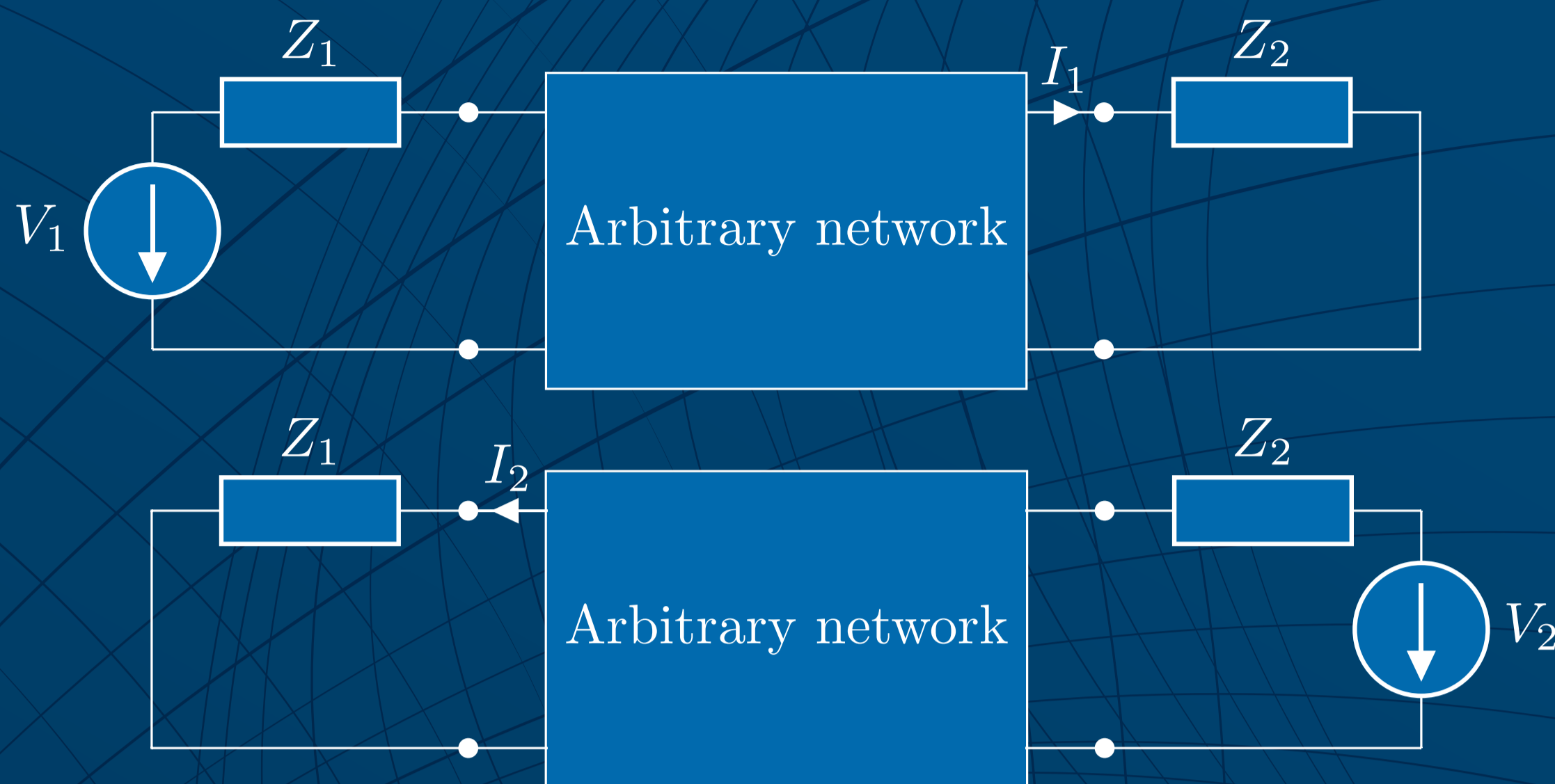
„... waves be excited at point A, the resulting velocity potential at point B is the same, as it would have been at A, had B been the source ...“

J. W. S. Rayleigh, The theory of sound

J. W. S. Rayleigh
12.11.1842 - 30.6.1919
Trinity College, Cambridge



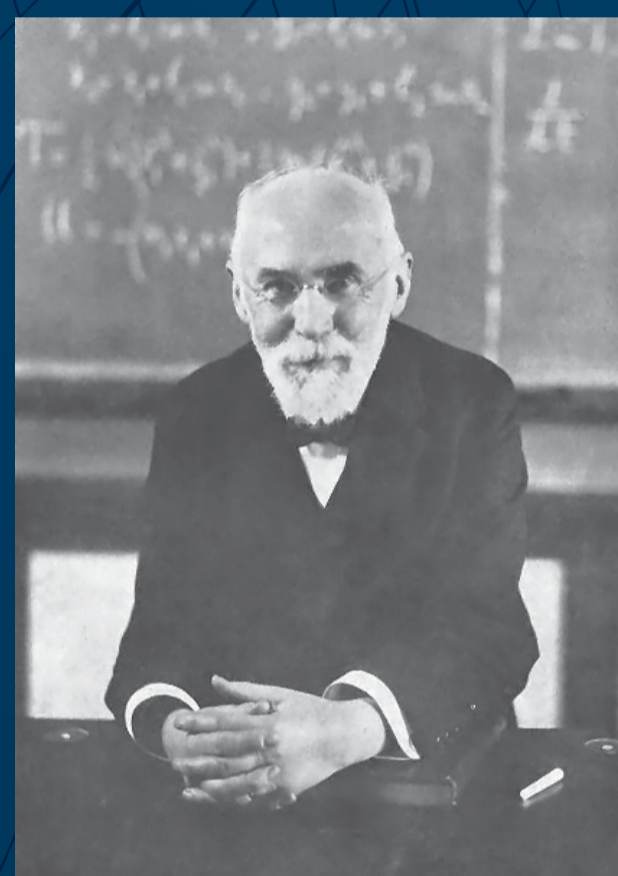
The theory of sound II (1894)



$$I_1 V_2 = I_2 V_1$$

valid for circuits

H. A. Lorentz
18.7.1853 - 4.2.1928
University of Leiden



Amsterdamer Akademie der Wetenschappen (1896)

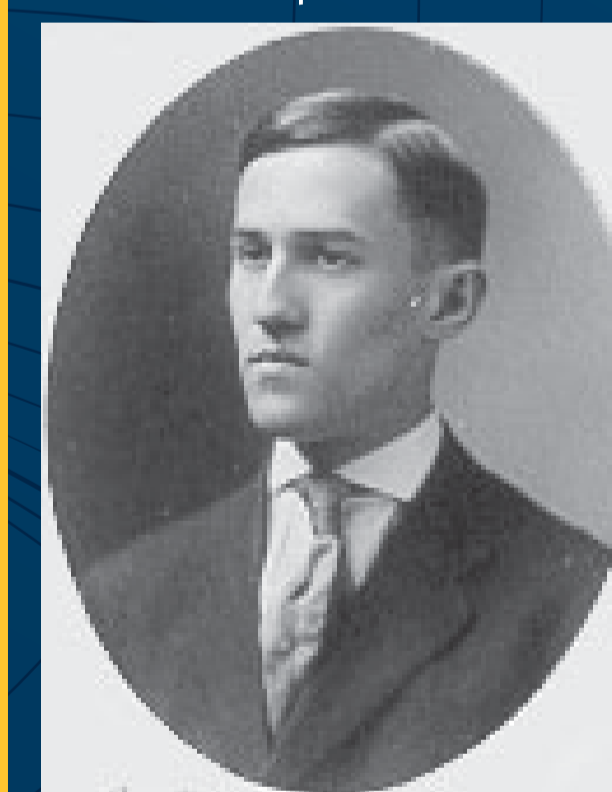
Did you know?

... that reciprocity is tightly connected with time reversal symmetry. When time reversal changes the setup of your system, the reciprocity does not apply.

$$\int_V (\mathbf{J}_1 \cdot \mathbf{E}_2 - \mathbf{J}_2 \cdot \mathbf{E}_1) dV = \oint_{\partial V} (\mathbf{E}_1 \times \mathbf{H}_2 - \mathbf{E}_2 \times \mathbf{H}_1) \cdot d\mathbf{S}$$

general form (side product of a play with Poynting's theorem)

J. R. Carson
28.6.1886 - 31.10.1940
Princeton University,
American Telephone & Telegraph,
Bell Telephone Laboratories



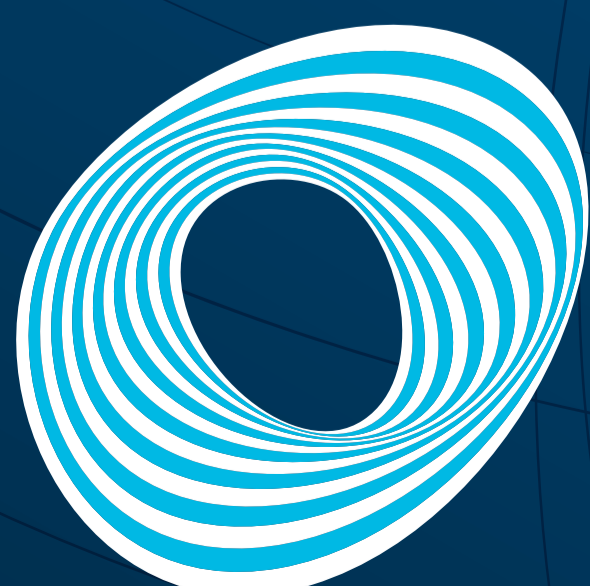
Proc. IRE (1929)

Challenge

Ideal operational amplifier is a linear device made of reciprocal materials. Why does the reciprocity not hold between input and output?

$$\int_{V_\infty} \mathbf{J}_1 \cdot \mathbf{E}_2 dV = \int_{V_\infty} \mathbf{J}_2 \cdot \mathbf{E}_1 dV$$

valid for radiating structures



EMiT
Electromagnetic
Tuesday



CTU
CZECH TECHNICAL
UNIVERSITY
IN PRAGUE