Thévenin/Norton Equivalent Ckts

Finding $V_t$:

- $V_t = V_{oc}$
- Loop-ckt voltage.

Finding $I_n$:

- $I_n = \frac{V_{oc}}{R_c}$
- Short-ckt current.

Finding $R_t$:

- $V_t = V_{oc} + \frac{V_{oc}}{R_t}$
- Short-ckt current

Finding $R_n$:

- $I_n = \frac{V_{oc}}{R_c}$
- $V_{oc} = R_n \cdot I_{sc} = \frac{V_{oc}}{I_{sc}}$

Example:

- $V = \frac{V_{oc}}{R_1}$
- $2(\frac{V-V_{oc}}{R_1}) = \frac{V_{oc}}{R_2} = 3\frac{V}{R_1} = \frac{V_{oc}}{R_2} + 3\frac{V_{oc}}{R_1} = V_{oc}\left(\frac{R_1+3R_2}{R_1R_2}\right)$

- $I_2 = \frac{V}{R_1}$
- $I_{sc} = 3i_2 = \frac{3V}{R_1}$

Thus $V_t = V\left(\frac{3R_2}{R_1+3R_2}\right)$, $I_n = \frac{3V}{R_1}$, $R_t = R_n = \frac{R_1R_2}{R_1+3R_2}$
Thermionic/Norton Equivalence (cont.)

Source Transformation:

\[ V_o = V_t + \frac{V_t}{R_t} \quad \Rightarrow \quad I_n = -\frac{V_t}{R_t} \]

\[ R_m = R_t \quad \Rightarrow \quad V_{oc} = V_t \]

\[ I_{sc} = \frac{V_{oc}}{R_t} \quad \Rightarrow \quad I_n = \frac{V_{sc}}{R_t} \]

Example:

\[ R = 20 \quad \Rightarrow \quad 10 \quad \Rightarrow \quad 10 \quad \Rightarrow \quad 10 \]

Maximum power transfer: Maximum power transfer occurs when load resistance equals Thermionic resistance.

\[ P_L = \frac{V_L^2}{R_L} = \frac{V_t^2 R_L}{(R_L + R_t)^2} \]

\[ \frac{dP_L}{dR_L} = 0 \quad \Rightarrow \quad R_L = \frac{R_t}{R_L + R_t} \]

\[ R_L = R_t \quad \Rightarrow \quad P_L = \frac{V_t^2}{R_t} \]

Application: For small power applications such as extracting received signal power from receiving antenna, it is important that radio receiver offers a load that matches the Thermionic resistance of antenna.

(At high level, antenna can be viewed as a Thermionic source, and radio receiver a load.)

For small power applications such as lighting a bulb, load is usually much higher than the Thermionic resistance of source to minimize the losses in the source.