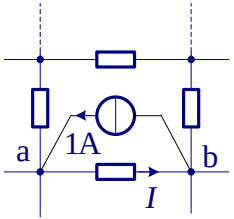
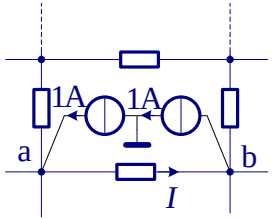
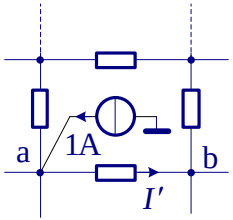
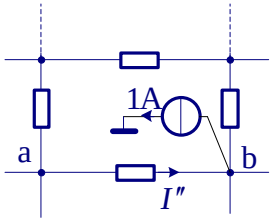
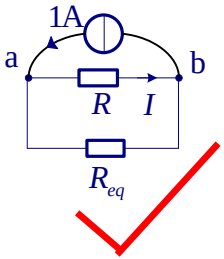
课前练习： 题图所示无限方格电阻电路四周均伸向无穷远处接地，其中所有电阻均为1Ω，试求下面各图中的I和R_{ab}

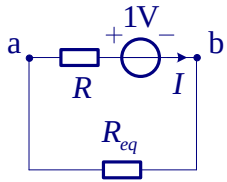




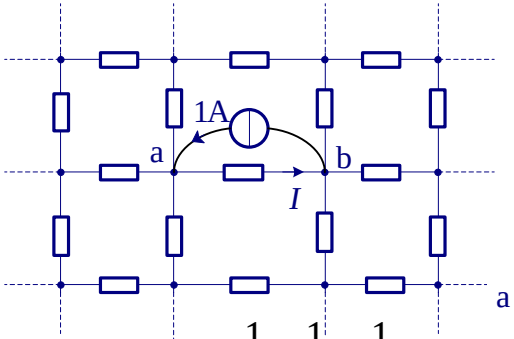




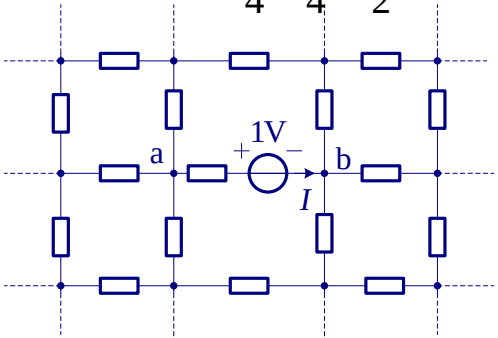


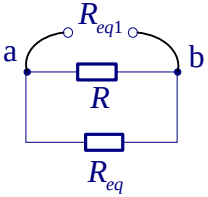


$$I = -\frac{U_S}{R + R_{eq}} = -\frac{1}{2}\text{A}$$

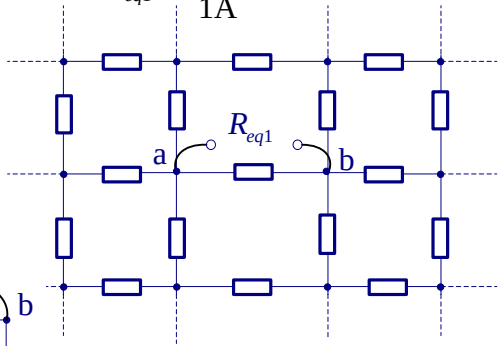


$$I = I' + I'' = \frac{1}{4} + \frac{1}{4} = \frac{1}{2}\text{A}$$

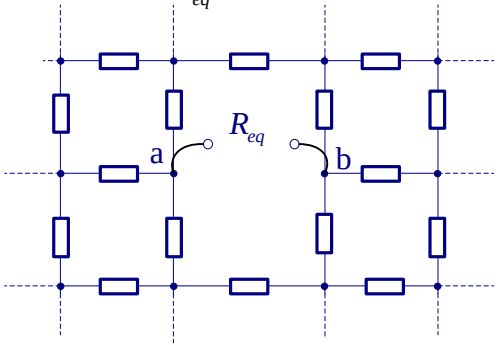




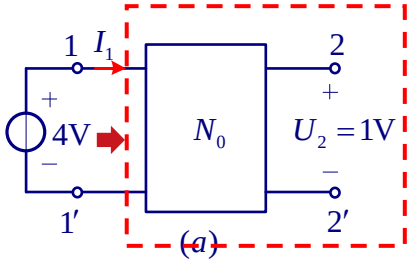
$$R_{eq1} = \frac{0.5\text{V}}{1\text{A}} = 0.5\Omega$$

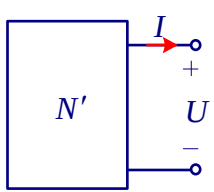


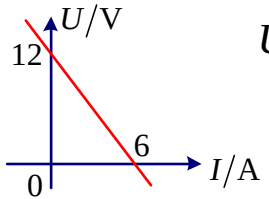
$$R_{eq} = R = 1\Omega$$



例： 电路如图(a)所示，N_0为线性电阻网络，端口11'接4V电压源时，I_1=2A，22'端口开路电压U_2=1V。今若在11'端口改接图(b)所示的含源线性电阻网络N'，N'的伏安特性如图中所示，试求此时端口22′的开路电压。

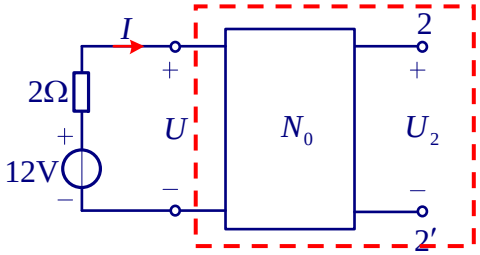




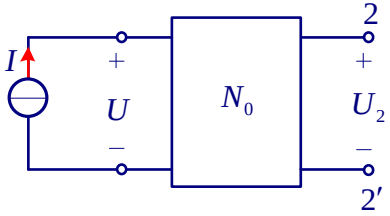


(b)

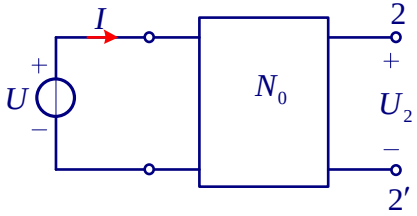
$$U = 12 - 2I$$



$$R_{eq} = \frac{4}{2} = 2\Omega$$



$$\frac{U_2}{3} = \frac{1}{2}$$

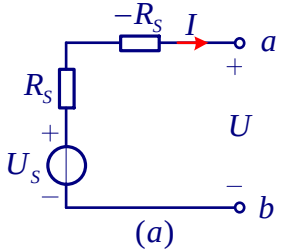


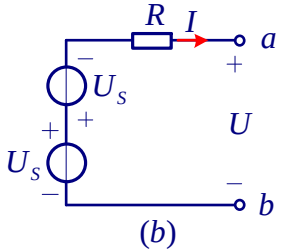
$$\frac{U_2}{6} = \frac{1}{4}$$

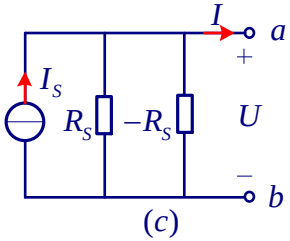
$$I = \frac{12}{2 + R_{eq}} = 3\text{A}$$

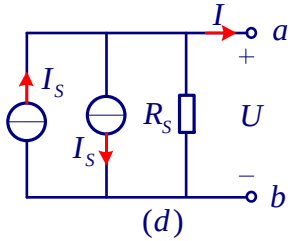
$$U = 12 - 2I = 6\text{V}$$

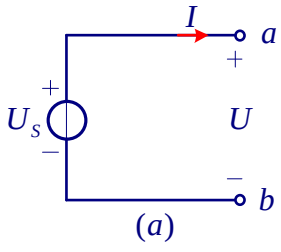
思考：

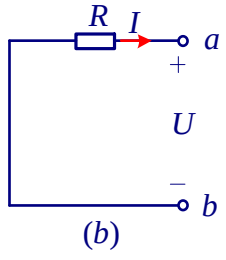

−R_S
I
a
R_S
+
U
U_S
−
b
(a)

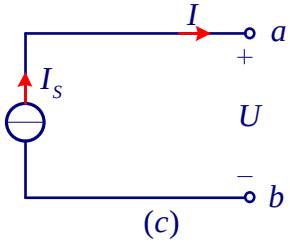

R
I
a
U_S
+
U
−
b
(b)

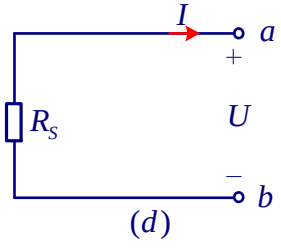

I
a
I_S
R_S
−R_S
+
U
−
b
(c)


I
a
I_S
R_S
I_S
+
U
−
b
(d)


I
a
+
U_S
U
−
b
(a)


R
I
a
+
U
−
b
(b)

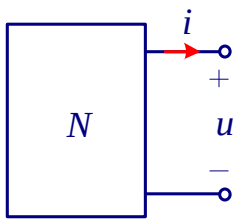

I
a
I_S
+
U
−
b
(c)


I
a
R_S
+
U
−
b
(d)

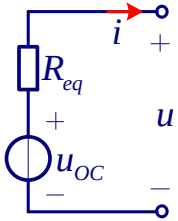
4、戴维宁定理/诺顿定理

线性含源一端口网络N，可以用一个独立电压源u_{oc}与一个电阻R_{eq}的串联组合来等效。其中，电压源的电压u_{oc}等于该网络N的开路电压；电阻R_{eq}为该网络N中全部独立电源置零后所得网络N_0的等效电阻——戴维宁等效

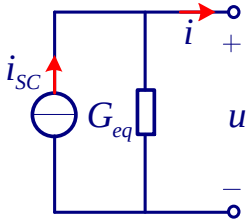
线性含源一端口网络N，可以用一个独立电流源i_{sc}与一个电阻R_{eq}的并联组合来等效。其中，电流源的电流i_{sc}等于该网络N的短路电流；电阻R_{eq}为该网络N中全部独立电源置零后所得网络N_0的等效电阻——诺顿等效



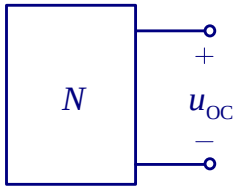
(a)

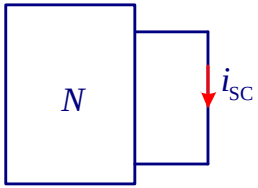


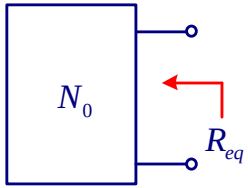
(b)



(c)

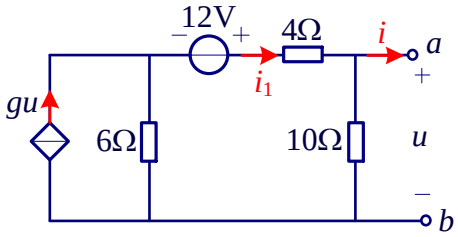




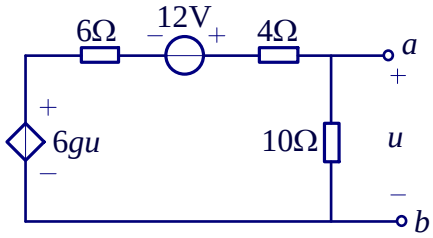


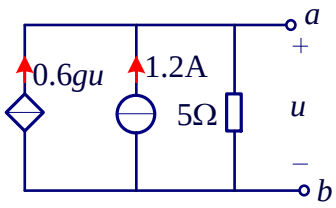
$$u_{OC} = R_{eq} i_{SC}$$

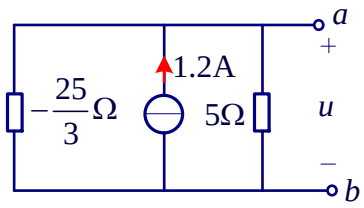
例：图示电路中转移电导g=0.2S，试求从ab端看进去的戴维宁等效和诺顿等效电路

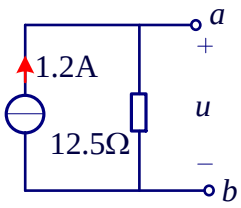


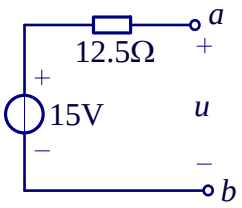
方法一：电源等效变换







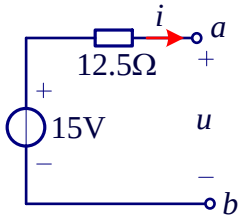




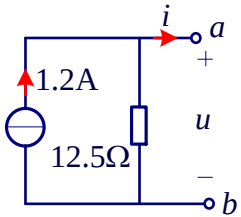
方法二：端口特性方程

$$\begin{cases} u = 10(i_1 - i) \\ 12 = 4i_1 + u + 6(i_1 - gu) \end{cases}$$

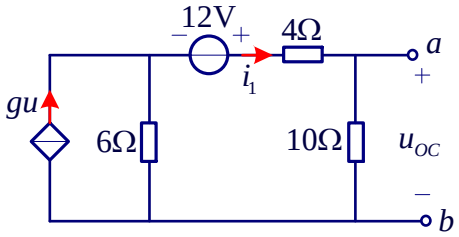
$$u = 15 - 12.5i$$



$$i = 1.2 - \frac{u}{12.5}$$

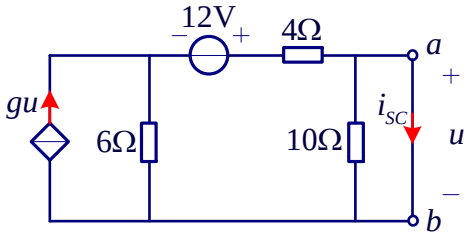


例：图示电路中转移电导g=0.2S，试求从ab端看进去的戴维南等效和诺顿等效电路

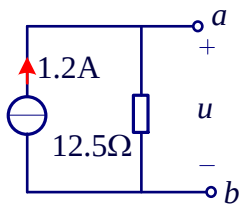


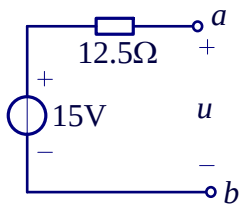
方法三：求开路电压、短路电流/等效内阻

$$\begin{cases} u_{OC} = 10i_1 \\ 12 = 14i_1 + 6(i_1 - gu_{OC}) \end{cases} \qquad u_{OC} = 15\text{V}$$

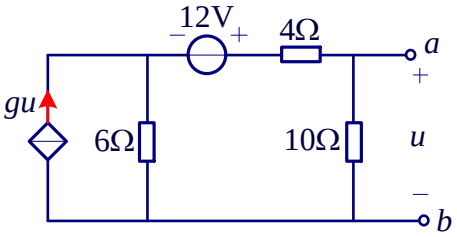


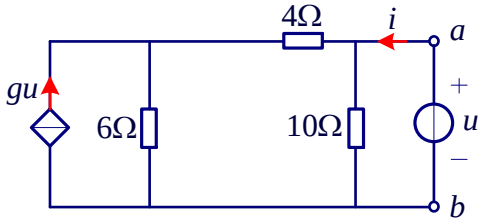
$$\begin{cases} u = 0 \\ 12 = 4i_{SC} + 6(i_{SC} - gu) \end{cases} \qquad i_{SC} = 1.2\text{A} \qquad R_{eq} = \frac{U_{OC}}{i_{SC}} = \frac{15}{1.2} = 12.5\Omega$$



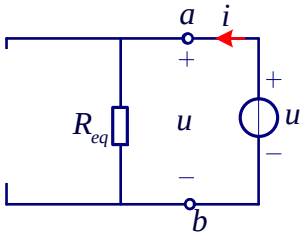


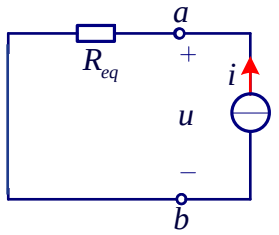
例：图示电路中转移电导g=0.2S，试求从ab端看进去的戴维南等效和诺顿等效电路





等效电阻的计算方法四：外施电源法



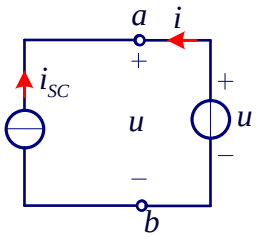


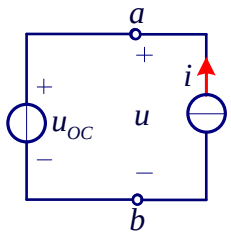
$$R_{eq}=\frac{u}{i}$$

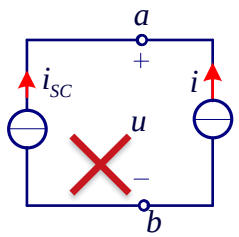
$$4\left(i-\frac{u}{10}\right)+6\left(i-\frac{u}{10}+gu\right)=u$$

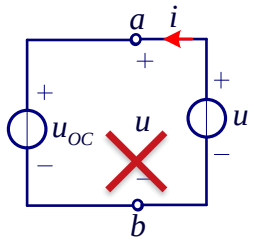
$$\frac{u}{i}=12.5\Omega$$

思考：

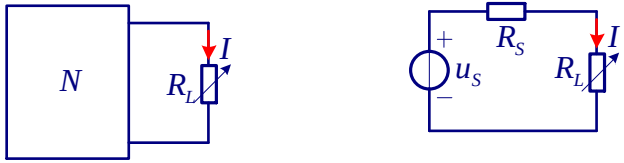








应用：最大功率传输

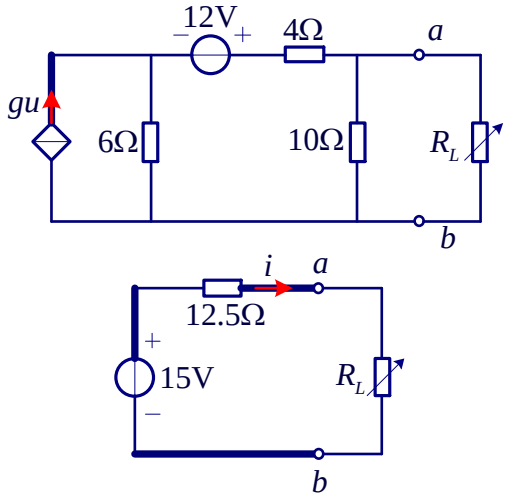


$$P = I^2 R_L = \left(\frac{U_{OC}}{R_L + R_{eq}} \right)^2 R_L = \frac{R_L U_{OC}^2}{\left(R_L + R_{eq} \right)^2}$$

$$\frac{dP}{dR_L} = \frac{(R_{eq} + R_L)^2 U_{OC}^2 - 2(R_{eq} + R_L) R_L U_{OC}^2}{(R_{eq} + R_L)^4} = \frac{(R_{eq} - R_L) U_{OC}^2}{(R_{eq} + R_L)^3} = 0$$

最大功率传输条件：$R_L = R_{eq}$（负载匹配）

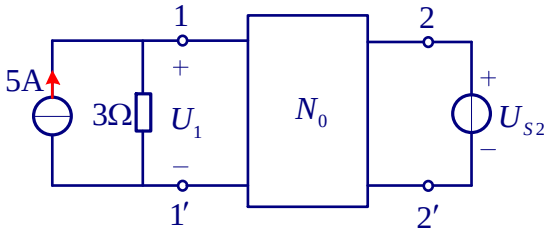
$$P_{\max} = I^2 R_L = \left(\frac{U_{OC}}{R_{eq} + R_L} \right)^2 R_L = \frac{U_{OC}^2}{4 R_{eq}}$$

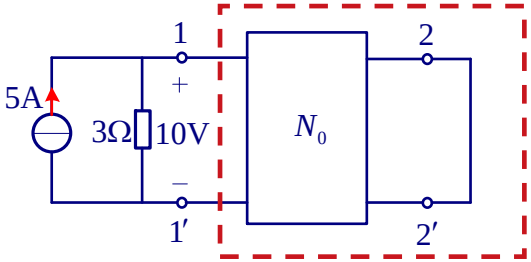


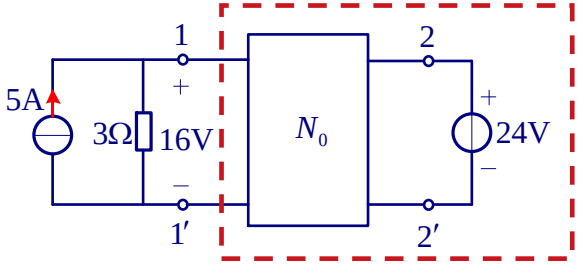
最大功率传输条件：$R_L = R_{eq} = 12.5\Omega$

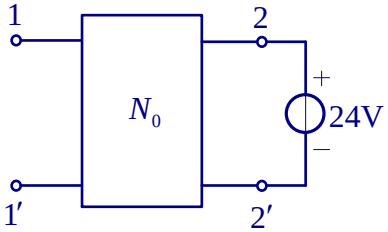
最大功率：$P_{\max} = \frac{u_{OC}^2}{4R_L} = \frac{15^2}{4 \times 12.5} = 4.5\text{W}$

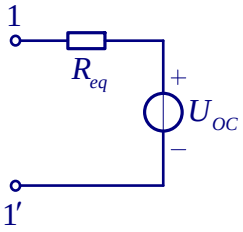
例： 图示电路中，N_0为不含源线性电阻网络。当2-2′端短路时，U_1=10V；当2-2′端接U_{S2}=24V电压源时，U_1=16V，求此时从1-1′端向右的戴维宁等效电路。

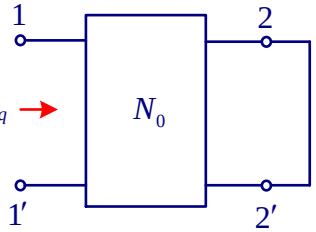


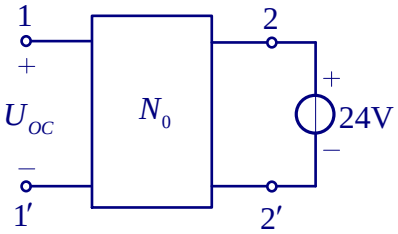




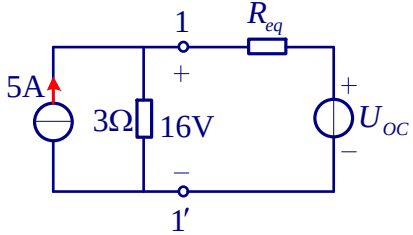








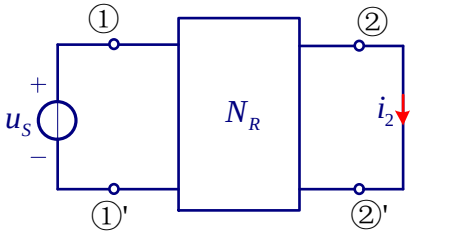
$$R_{eq}=\frac{10}{5-\frac{10}{3}}=6\Omega$$

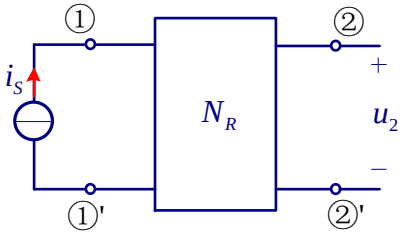


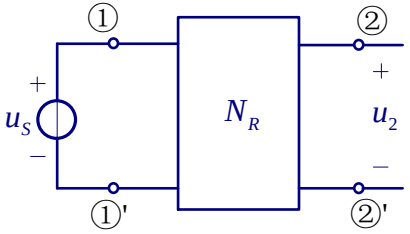
$$U_{OC}=16+R_{eq}\left(\frac{16}{3}-5\right)=18\text{V}$$

5、互易定理

前后变换，关联相反







前后移动
关联相同