4–3 Find the voltage gain v_O/v_S and current gain i_O/i_x in Figure P4–3 for $g = 2\times10^{-3}$ S. For $v_S = 5$ V, find the power supplied by the input voltage source and the power delivered to the 2-kΩ load resistor.

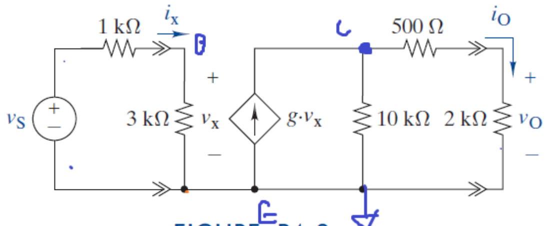


FIGURE P4–3

$\boxed{u_o/u_s}$

$$i_x = \frac{V_x}{3K\Omega} \quad (1)$$

$$V_x = V_s\cdot\frac{3K}{3K+1K} = \frac{3}{4}V_s \quad (2)$$

1ος τρόπος

Thevenin στην εξαρτημένη: μπορείς γιατί δεν εξαφανίζεται η εξάρτηση

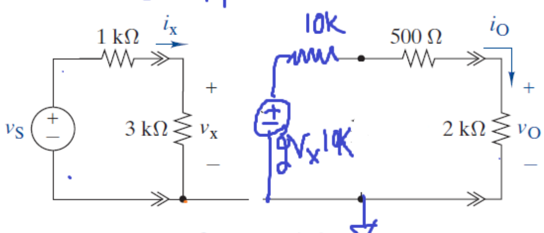


FIGURE P4–3

Διαιρέτης τάσης

$$u_o = gV_x 10K\cdot\frac{2K}{12{,}5K} = gV_x\frac{8}{5}10^3 =$$

$$= g\cdot\frac{3}{\cancel{4}}V_s\cdot\frac{\cancel{8}^{2}}{5}\cdot10^3 \Rightarrow \boxed{\frac{u_o}{u_s} = g\cdot\frac{6}{5}\cdot10^3\ \frac{V}{V}} = \frac{12}{5}\frac{V}{V}$$

2ος τρόπος: διαιρέτης ρεύματος πάνω στον κόμβο C

$$i_o = gV_x\cdot\frac{10K}{10K+500+2K} \qquad I_2 = \pm I\frac{R_1}{R_1+R_2}$$

$$V_o = i_o\cdot 2K = gV_x\frac{20\cdot10^3}{12{,}5} = gV_x\frac{8}{5}\cdot10^3 \quad \ldots$$

$$V_o = g\cdot V_x\frac{8}{5}\cdot10^3 \Leftrightarrow i_o\cancel{2K} = g\cdot i_x\cdot 3K\cdot\frac{\cancel{8}^{4}}{5}\cdot10^3 \Leftrightarrow \frac{i_o}{i_x} = g\cdot\frac{12\cdot10^3}{5} =$$

$$= \frac{2\cdot\cancel{10^{-3}}\cdot12\cdot\cancel{10^3}}{5} = \boxed{\frac{24}{5}\frac{A}{A}}$$

$$P_s = V_s\cdot i_x = V_s\cdot\frac{V_s}{(1+3)K} = \frac{25\cdot10^{-3}}{4} = \boxed{6{,}25mW}$$

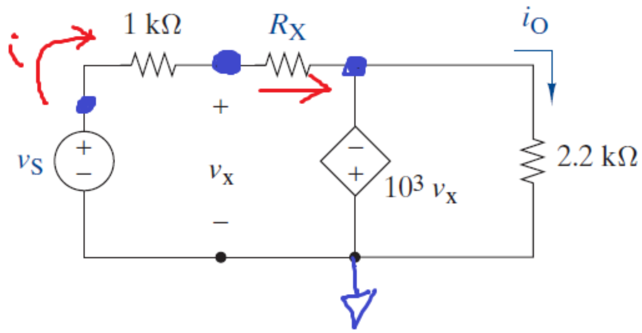
V^2/R

$$P_o = V_o i_o = \frac{V_o}{V_s}\cdot V_s\cdot\frac{i_o}{i_x}\cdot i_x = \frac{V_o}{V_s}\cdot\frac{i_o}{i_x}\cdot V_s\cdot\frac{V_s}{4K} =$$

$$= \frac{12}{\cancel{5}}\cdot\frac{\cancel{24}^{6}}{\cancel{5}}\cdot\frac{\cancel{5}\cdot\cancel{5}}{\cancel{4}\cdot10^{-3}} = \boxed{72mW}$$

4–8 **(a)** Find an expression for the gain i_O/v_S in Figure P4–8 in terms of R_X.

(b) Select a value for R_X so that the gain is -0.227.



$$i_o = -\frac{10^3 V_x}{2.2k\Omega} = -\frac{V_x}{2.2} \quad (1)$$

$$i = \frac{V_x + 10^3 V_x}{R_x} = \frac{1001 V_x}{R_x} \quad (2)$$

$$V_s - \frac{1001 V_x}{R_x} 1K = V_x \Rightarrow V_x\left(1 + \frac{1001 \cdot 10^3}{R_x}\right) = V_s \Rightarrow V_x\left(\frac{R_x + 1001 \cdot 10^3}{R_x}\right) = V_s \Rightarrow$$

$$\Rightarrow V_x = \frac{R_x}{R_x + 1001 \cdot 10^3} V_s \quad (3)$$

$$\boxed{i_o = -\frac{V_s}{2.2}\left(\frac{R_x}{R_x + 1001 \cdot 10^3}\right)}$$

4–9 Find an expression for the voltage gain v_O/v_S in Figure P4–9.

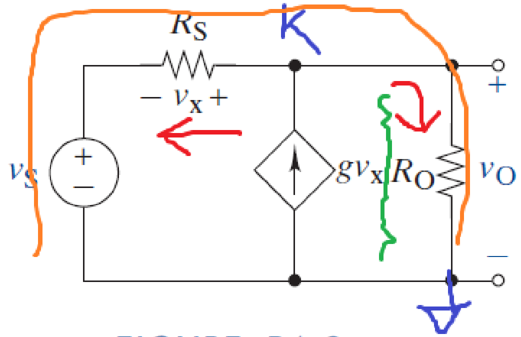


FIGURE P4–9

Νόμος Ρευμάτων Kirchoff, όπου τα ρεύματα γράφονται σαν τάσεις:
Μέθοδος Κόμβων Nodal Analysis

$$gV_x = \frac{V_x}{R_S} + \frac{V_o}{R_o} \Leftrightarrow V_x\left(g - \frac{1}{R_S}\right) = \frac{V_o}{R_o} \Leftrightarrow V_x\left(\frac{gR_S - 1}{R_S}\right) = \frac{V_o}{R_o} \quad (1)$$

$$V_s + V_x - V_o = 0 \Leftrightarrow V_x = V_o - V_s \quad (2)$$

$$(V_o - V_s)\left(\frac{gR_S - 1}{R_S}\right) = \frac{V_o}{R_o} \Leftrightarrow$$

$$\Leftrightarrow R_o(V_o - V_s)(gR_s - 1) = R_s V_o \Leftrightarrow V_o[R_o(gR_s - 1) - R_s] = R_o V_s (gR_s - 1) \Leftrightarrow$$

$$\Rightarrow \frac{V_o}{V_s} = \frac{R_o \cdot (gR_s - 1)}{[R_o(gR_s - 1) - R_s]}.$$

4–10 (a) Find an expression for the voltage gain v_O/v_S in Figure P4–10.

(b) Let $R_S = 10$ kΩ, $R_L = 10$ kΩ and $\mu = 100$. Find the voltage gain v_O/v_S as a function of R_F. What is the voltage gain when R_F is an open circuit, a short circuit, and for $R_F = 100$ Ω?

(c) Simulate the circuit in OrCAD by varying R_F from 1 Ω to 10 MΩ. Read your output $R_F = 100$ Ω. How does your answer compare with part (b)?

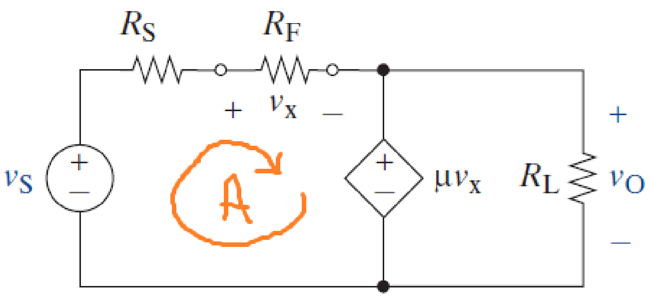


FIGURE P4–10

$$\boxed{V_o = \mu V_x} \quad (1)$$

$$V_s - \underbrace{\frac{V_x}{R_F}}_{i} R_s - V_x = \mu V_x \Leftrightarrow$$

$$\Leftrightarrow V_s \cdot R_F = V_x \left(R_s + R_F + \mu R_F\right) \Leftrightarrow$$

$$\Rightarrow V_x = \frac{V_s \cdot R_F}{R_s + (\mu+1)R_F}$$

$$\boxed{\frac{V_o}{V_s} = \mu \cdot \frac{R_F}{R_s + (\mu+1)R_F}}$$

A_v $R_F \to \infty$

$$\lim_{R_F \to \infty} \frac{V_o}{V_s} = \boxed{\frac{\mu}{\mu+1}}$$

A_v $R_F \to 0$

$$\lim_{R_F \to 0} \frac{V_o}{V_s} = \boxed{0}$$

4–17 Find the Norton Equivalent circuit seen by the load in Figure P4–17.

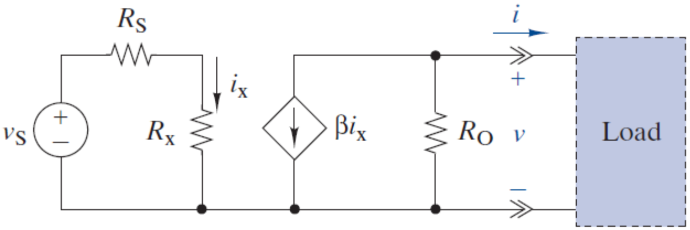
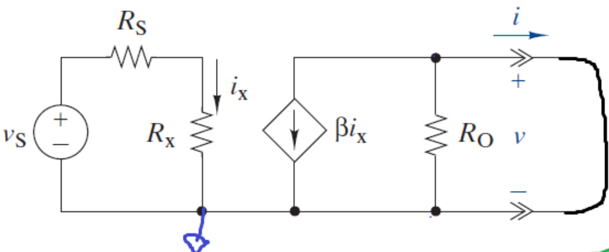


FIGURE P4–17

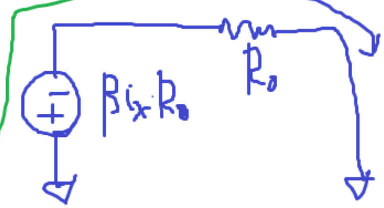
Κατευθείαν Norton:
βραχυκυκλώνεις τους ακροδέκτες και ψάχνεις το ρεύμα βραχυκύκλωσης



$$i = \beta i_x$$

$$i_x = \frac{V_s}{R_s + R_x}$$

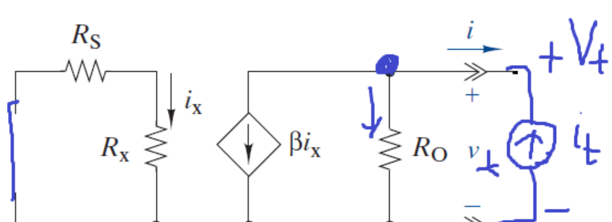
$$\boxed{i = \beta \frac{V_s}{R_s + R_x}}$$



$$i = \frac{\beta i_x R_o}{R_o} = \boxed{\beta i_x}$$

$$R_N = R_{th} = V_t / i_t$$

βραχυκυκλώσαμε τη Vs



δεν υπάρχει ρεύμα

βάζουμε δοκιμαστική πηγή

$$i_t = \frac{V_t}{R_o} + \beta i_x = \frac{V_t}{R_o} + \beta \cdot 0 \Leftrightarrow R_N = \frac{V_t}{i_t} = \boxed{R_o}$$