EC1010: Electrical and Magnetic circuits.

Note Title 1/28/2013

Problem set #3 (Due on 25th Feb. 2013)

HKD: Hayt, Kemmerly, and Durbin

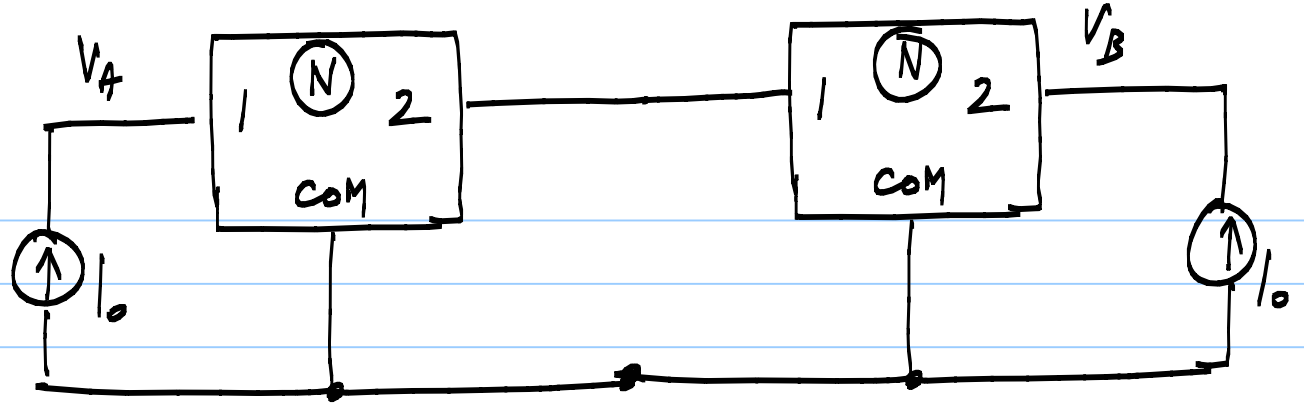
Engineering circuit analysis, 7th Edition

Tata McGraw Hill 2010, 2006

1. Prove power conservation ($\sum_{\text{branches}} v_k i_k = 0$) for an arbitrary electrical network.

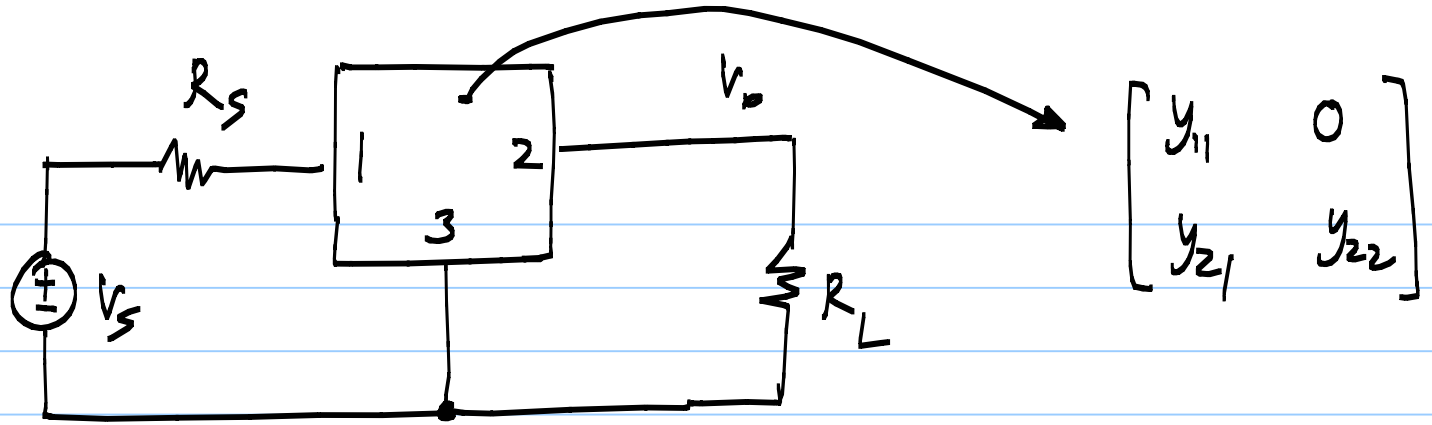
(Hint: Express all branch voltages in terms of node voltages wrt a reference node and group together coefficients of each node voltage)

2.



The circuit above is made using two identical resistive 3 terminal two port networks N driven by identical current sources I_o. Determine V_A and V_B in terms of I_o and z-parameters of N. (This problem can be solved using brute force, but will be easier if you use reciprocity appropriately).

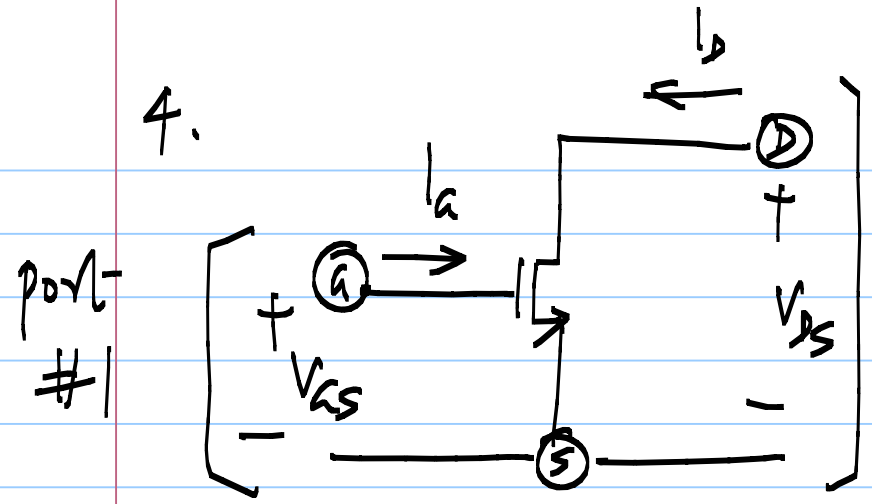
3.



Determine V_o/V_s. Assuming all positive y parameters, determine the constraints on them to maximize

$$\left| V_o/V_s \right|$$

4.



An MOS transistor is a 3 terminal two port with the following relationships between voltages and currents.

$$i_G = 0 \; ; \quad i_D = \frac{\beta}{2}\left(v_{GS} - V_T\right)^2 \left(1 + \lambda v_{DS}\right)$$

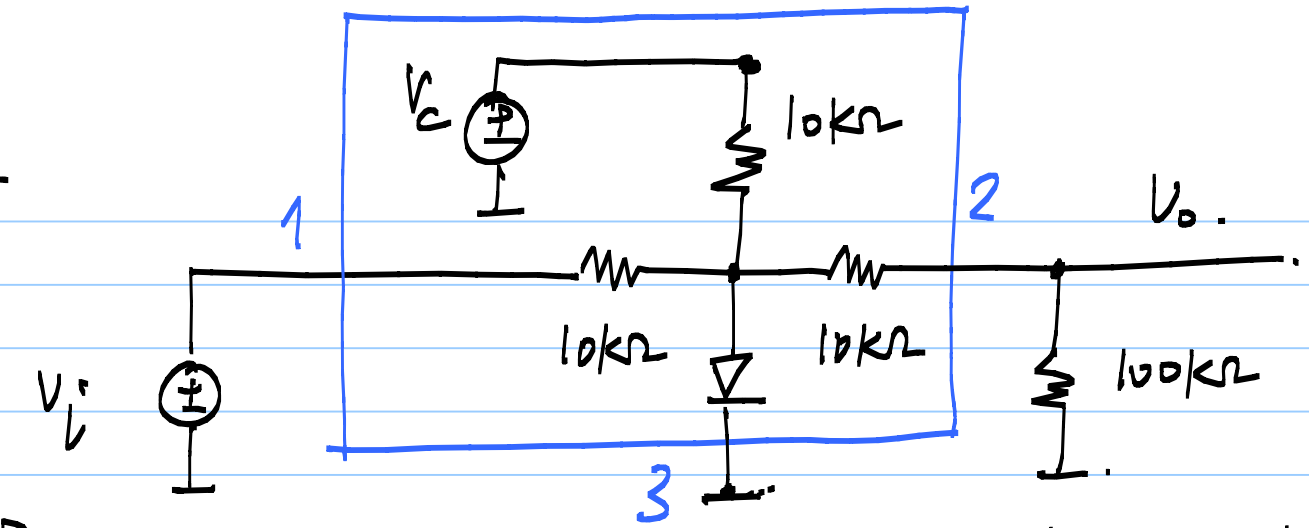
β, V_T, and λ are constants.

Determine the incremental y parameters of the transistor.

5. Evaluate the y parameters of the previous problem for $\beta = 100\mu A/V^2$; $V_T = 1\,V$; $\lambda = 0.01\,V^{-1}$ at an operating point of $V_{GS} = 3V$, $V_{DS} = 5V$.

If the network in problem 3 has these y-parameters, determine $\frac{V_o}{V_s}$ for $R_s = R_L = 100K\Omega$

6.



[Treat v_i as an incremental input].

Determine the total output v_o when $V_c = +2.7V$ and $V_c = -2.7V$

7. In the previous problem, determine the small-signal y-parameters of the 3 terminal two port enclosed by the box for $V_C = 2.7V$ and $V_C = -2.7V$.