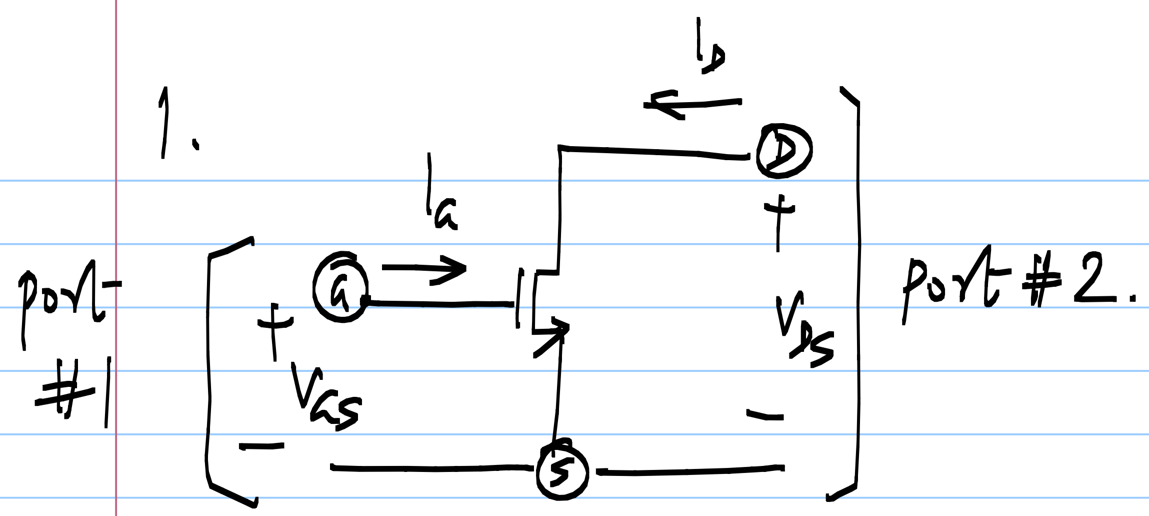
EE1001 Electrical and Magnetic Circuits
Problem set #5 (Due on 27th February 2015)

1.



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

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

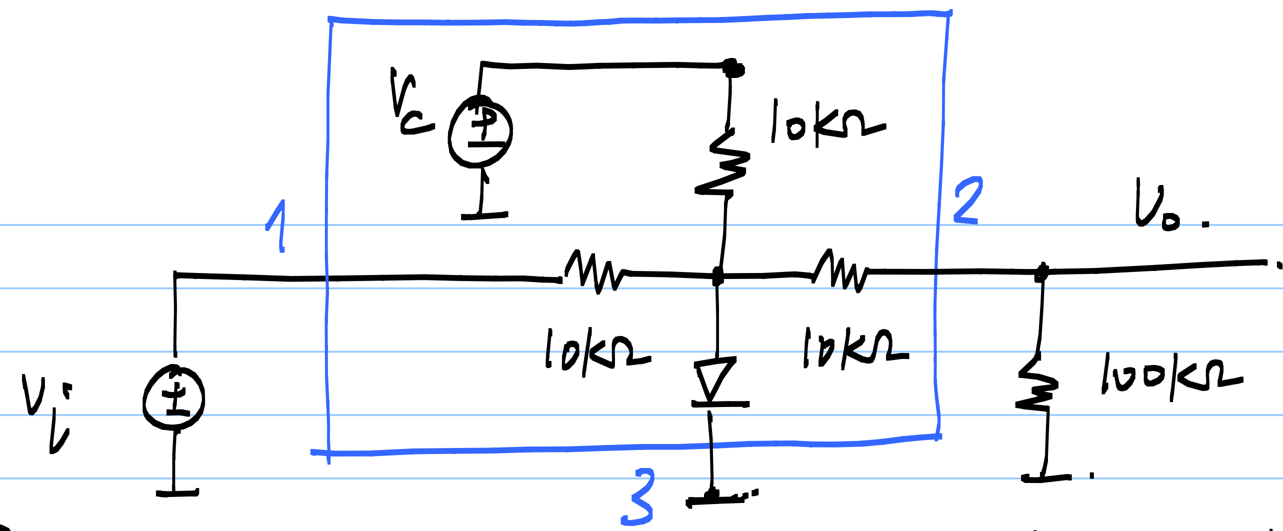
β, V_T, and λ are constants.

Determine the incremental y parameters of the transistor.

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

If the network in problem 10 of the previous problem set has these y-parameters, determine $\frac{V_o}{V_s}$ for $R_S = R_L = 100k\Omega$

3.

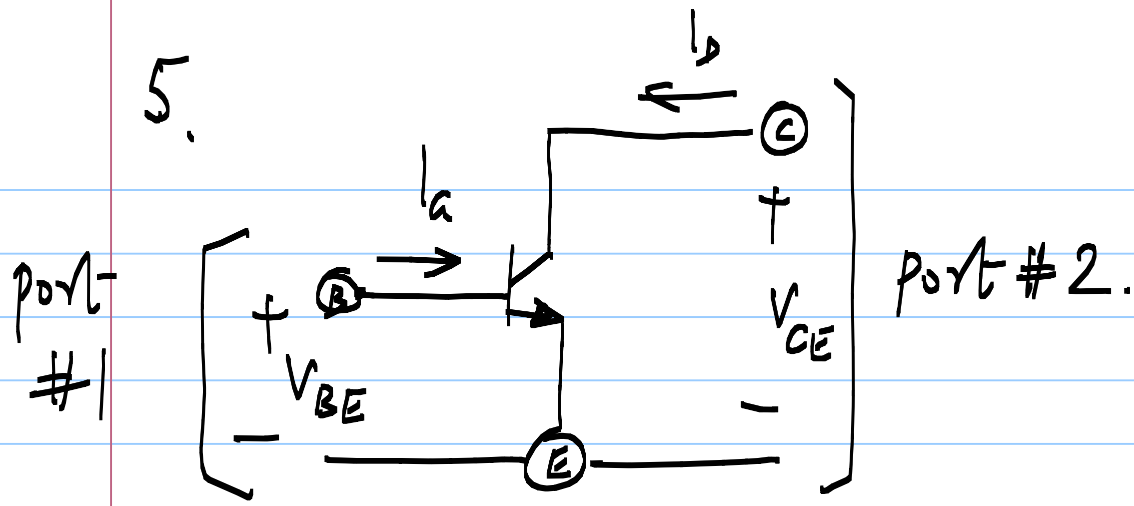


[Treat v_i as an incremental input].

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

4. 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 $V_c = -2.7V$.

5.



A bipolar junction transistor is a 3 terminal two port with the following relationships between voltages and currents.

$$I_B = \frac{I_c}{\beta}; \quad I_c = I_s \exp\left(\frac{V_{BE}}{V_t}\right)\left(1 + \frac{V_{CE}}{V_A}\right);$$

I_s, V_A, β are constants. V_t is the thermal voltage.

Calculate the small-signal y-parameters.

6. Evaluate the y parameters of the previous problem for $\beta = 200$, $I_s = 10^{-15}A$, $V_A = 25V$, at an operating point of $V_{BE} = 690mV$, $V_{CE} = 2.5V$ (Use $V_t \simeq 25mV$)

If the network in problem 10 of the previous problem set has these y-parameters, determine $\frac{V_o}{V_s}$ for $R_s = R_L = 100k\Omega$