

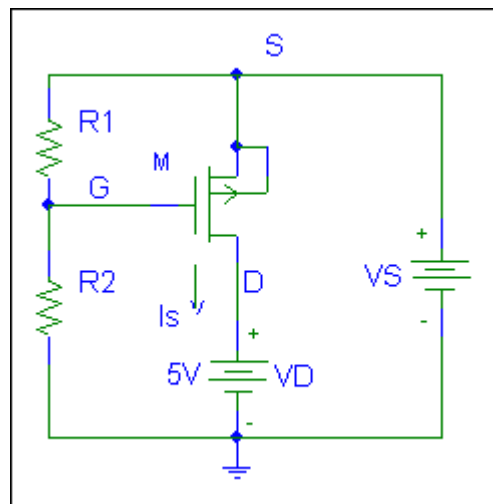
**CIRCUITS – Ph.D. Qualifying Exam Fall 2008**

1. 5 points (current source)

- a) In terms of the ratio of  $x = R1/R2$  and for the drain battery voltage  $V_D = 5V$ , find the minimum source battery voltage,  $V_S$ , needed to place the PMOS transistor in the saturation region. Assume that when in saturation

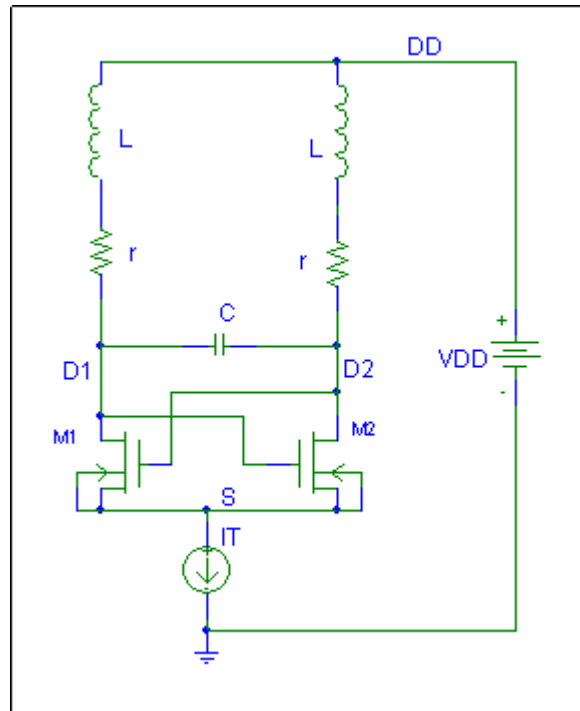
$$|I_D| = 4 \cdot 10^{-4} (|V_{GS}| - 1)^2$$

- b) Using the results of a) for the case of  $x = 1$ , give the value of the current source current,  $I_s$ .



## 2. 15 points (wireless oscillator)

For the following circuit the DC bias tail current,  $I_T$ , is adjustable and of large enough value to insure the transistors to be turned on. For numerical calculations the element values are  $r = 2 \text{ Ohm}$ ,  $L = 50 \mu\text{H}$ ,  $C = 10 \text{ nF}$ , and  $V_{DD} = 10 \text{ V}$ . Also assume the transistors are in saturation with  $I_D = 4 \cdot 10^{-4} (V_{GS} - 1)^2$



- Show that the transistors are actually in saturation. Then determine the bias voltages at the nodes D1, D2 and S with respect to ground in terms of tail current  $I_T$ .
- Find the small signal conductance seen looking down into the transistors between the nodes D1 & D2, again in terms of tail current  $I_T$ .
- Find  $I_T$  necessary to obtain sinusoidal oscillations and then the frequency of oscillation.



