

ENEE 303 Midterm MakupExam, Spring 2011

Your signature guarantees that you have not discussed this Exam after receiving this sheet.

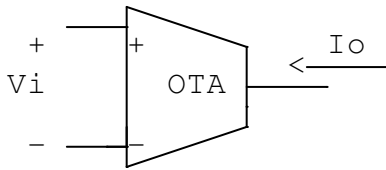
56 points, open book, open notes.

Due ~~Wednesday, April 6, 2011~~, Monday, April 11, at start of class.

Unless otherwise stated, for MOS transistors use 4007s, for BJTs assume Beta = 150 and for tail currents use 5mA. The 4007 Spice model parameters to be used are:

```
.model M4007N nmos(Level=1 Tox=300n Kp=20.54u W=144u L=8u Vto= 1.3
+ Lambda=15m Cbd=4p Cbs=4p)
.model M4007P pmos(Level=1 Tox=300n Kp=10.32u W=328u L=8u Vto=-1.5
+ Lambda=15m Cbd=8p Cbs=8p)
```

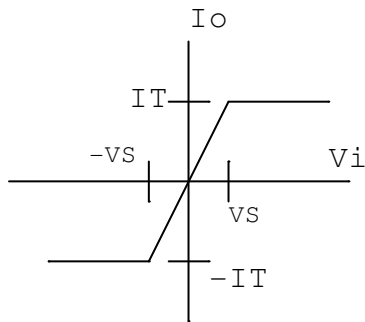
1. (10 points)



Using the above symbol for an OTA give the small signal Gm when biased at Vi=0 for (give in terms of literals and numerically)

- a) a BJT OTA
- b) an MOS OTA

2. (10 points) Ideally an OTA can be modeled by the following curve [along with zero input current]



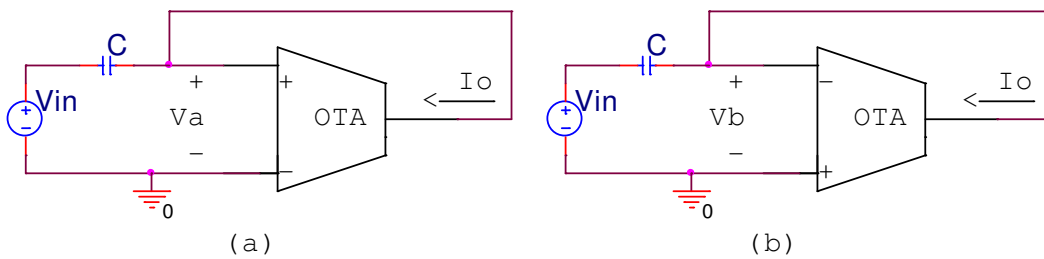
$$\text{For which } I_o = \begin{cases} IT & \text{for } V_S \leq V_i \\ G_m V_i & \text{for } -V_S \leq V_i \leq V_S \\ -IT & \text{for } V_i \leq -V_S \end{cases}$$

Give Gm in terms of the parameters indicated on the curve (not numerically)

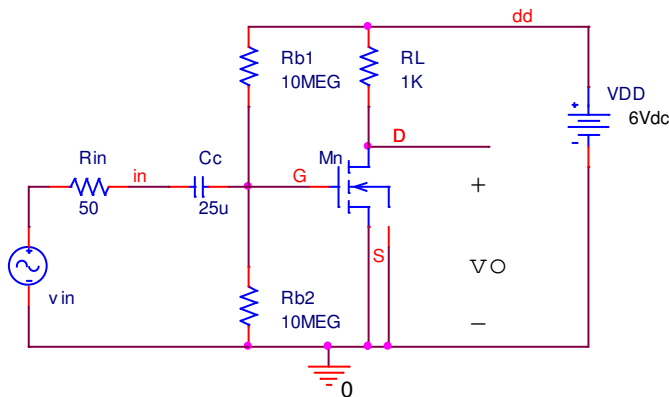
3. (18 points)

The ideal OTA of problem 2 is connected as shown below in two different configurations (NOTE that the OTA inputs are reversed). Assuming they are to be used for small signals around zero, for each circuit:

- Set up the differential equation for the OTA input voltage (V_a for (a) and V_b for (b))
- Give their impulse responses with V_{in} as input and V_a and V_b as outputs in time.
- Discuss the reason and meaning of the differences between V_a and V_b .



4. (18 points) For this circuit using a 4007 transistor



- Find the Q point values of V_{GS} , I_D and V_{DS} ; (be sure to include the Early effect and check the state of the transistor (saturation or Ohmic [=triode])).
- Give the g_m , g_o , and small signal mid-band gain, v_o/v_{in}

