

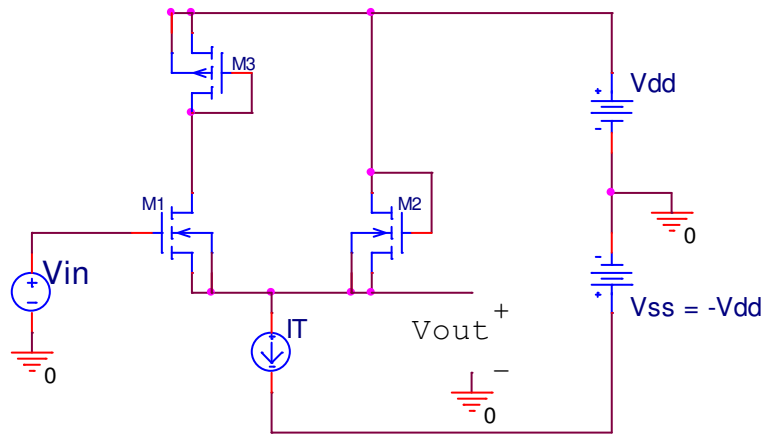
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 ENEE 303 Final Exam – Part one, Take home, Spring 2011  
 100 points, due at start of scheduled final exam period, 08:00 hour on May 17, 2011.

For numerical evaluation of MOS transistors use 4007s. The 4007 Spice model parameters 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. (100 points; 20 per part a)-e) +extra10 for f))

For the following circuit



- Using a 4007 transistor and another battery design the current source for  $I_T=1\text{mA}$ .
- Give a formula (at DC) for  $V_{out}$  versus  $V_{in}$  assuming M1 is in saturation,  $V_{dd}$  and  $I_T$  sufficiently large for proper bias, and generic transistors (not necessarily 4007s) with  $\beta=(KP/2)(W/L)$ ,  $V_{th}=V_{TO}$  and  $\lambda=0$ .
- Evaluate this equation for the 4007s assuming  $I_T=1\text{mA}$  and  $V_{dd}=5\text{V}$  (and  $\lambda=0$ ).
- Give a PSpice schematic for the circuit using 4007 transistors including the transistor construction of a) for the current source for  $I_T=1\text{mA}$ .
- Give PSpice results for  $V_{out}$  versus  $V_{in}$  for  $V_{ss}<V_{in}<V_{dd}=5$  and  $I_T=1\text{mA}$
- Compare the results of e) with your calculation in c) and discuss any differences.