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ENEE 303 Final Exam – Part two, one hour in class, Spring 2011

50 points, open book, open notes but not open computer. Good luck!

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)
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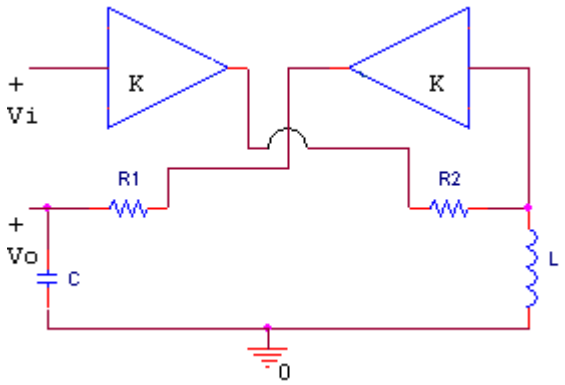
1. (25 points; 15 minutes)

The following circuit is to be designed to oscillate. Assuming ideal voltage controlled voltage sources of equal gain K,

a) Find the transfer function $T(s) = \frac{Vo}{Vi}(s)$, where Vo and Vi are measured with respect to ground. Give also zeros and poles of T(s).

b) Place a short between the input and output nodes, which sets Vo=Vi. The circuit can then become an oscillator. Give the conditions for oscillation and the oscillation frequency.



2. (25 points, 15 minutes)

A 4007 NMOS transistor is operated as a current source for 2mA at a load voltage across it of VDS = 5V. Give the designed VGS when LAMBDA is ignored and when it is taken into account and compare.

3. (50 points, 30 minutes)
Use the following ideal model for the OTA (with also zero currents into the + & - leads) for which IT and VS are real and positive.

$$Io = \begin{cases} IT & \text{for } VS \le Vid \\ GmVid & \text{for } -VS \le Vid \le VS \\ -IT & \text{for } Vid \le -VS \end{cases}$$

For the following circuit:
a) Give the equation for the load curve of IL versus Vo and graph the curve.
b) Graph -IL on the OTA curve of Io versus Vo when Vi = 0 for the two cases of Gm<G=1/R and Gm>G=1/R
c) The circuit has hysteresis for certain values of G=1/R. Determine the range of those values.
d) Graph Vo versus Vi to show the hysteresis for the values of R of part c) and give the hysteresis output values and input voltage jump point values. .