**EE429 - ı ¡ect 4 - FET op-amp**

**Purpose:**
The purpose of this project is design an operational amplifier using FETs, and sizing them like you would in designing an IC. This is a first cut, so you are allowed to use resistors but no large capacitors.

**What to do:**

You need to design a two stage op-amp, to the following specifications:

DC Voltage gain = 75 dB minimum, unloaded. (Design for 80 dB)
Output impedance, 10k ohms.
Output voltage swing: 20 volts peak-to-peak.
Power supply: + and - 15 volts.
Frequency response: DC to whatever. Do the best you can.
Use N-channel FETs with KP=20u, Lambda=0, Vto=1 (enhancement).
and P-channel FETs with KP=5u, Lambda=0, Vto=-1 (enhancement).
Try to minimize the area. Minimum feature size is 1u.

**Procedure:**

You need to determine any missing specs, and make sure that the specs are clear to you.

First, determine a reasonable topology, then determine component values. As a starting point, make the quiescent current of the diff-amp 10 uA.

After you are satisfied with the hand calculations, verify it with simulation. You must first verify the DC bias, then AC gain and frequency response, then the output voltage swing, using transient analysis.

Measure the open-loop frequency response magnitude and phase angle. Determine the uncompensated corner frequency and unity gain frequency.

In your Spice/Gnucap model, add the following capacitance parameters to both .model statements and measure it again.
cgdo=2e-10 cgso=2e-10 tox=50e-9

Determine the value of a compensation capacitor experimentally so the phase angle does not exceed 100 degrees for all frequencies for which the gain is larger than unity (0 db). This capacitor should be placed from drain to gate of the last stage. After determining the compensation, again measure the corner frequency and unity gain frequency.

After all this, also measure the common-mode gain, and compare it to the differential-mode gain.

**What to hand in:**

Your report should consist of the following sections:

1. A cover sheet, with a schematic on it.
2. Specifications, in two columns, requested and simulated, also on cover.
3. Design calculations.
4. Manual design verification.
5. Simulation procedures and results.
6. Discussion
7. References and acknowledgements

**Discussion:**

In your discussion, you should point out any difficulties with the procedure, including any deviations between the predicted results and the results obtained by simulation. You should also justify any design decisions you made. If you chose to relax any of the specs, justify it here.

**References and acknowledgements:**

List all sources of information here, including texts, faculty, and classmates. You will not be penalized for working together with other students, if you say so. You will be penalized if you claim the work of someone else as your own.

**Due date:**
This project is due [redacted]
6th Monday