# EECS 290C: Advanced circuit design for wireless
## Homework # 4

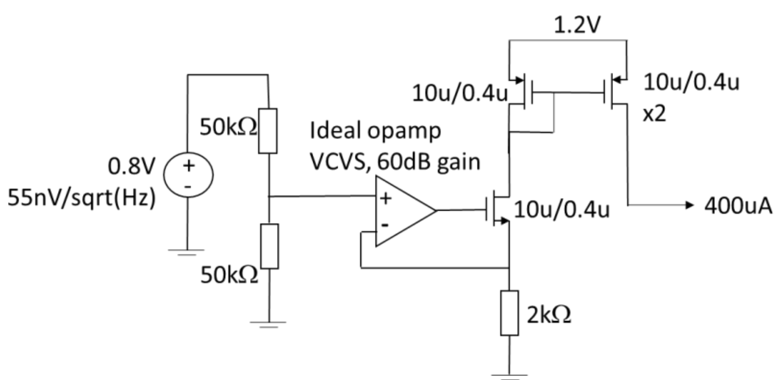
Q1. For the LNA you designed in HW3:

a. Use the provided portion of a QFN48 package with exposed paddle to house your LNA. The LNA is allowed to have a max of 4 external pins and as many ground down bonds to the paddle as you want (within reason). Arrange LNA pins and downbonds so that the LNA is unconditionally stable with $K_f > 1$ for all frequencies. Make sure that input/output return loss, S11 and S22, stay 10dB min at 2.5GHz. You may want to adjust your design and on-chip inductors to absorb the package bondwire inductance.

b. Simulate/plot NF/NFmin, S-parameters and $K_f$ for LNA.

c. Simulate the LNA IIP3, assuming two-tones at 2.5GHz and 2.49GHz each of -40dBm power. Try to draw the signature diagram by sweeping the tone power and plot IM3 and fundamental power vs. $P_{in}$. Double the current in the LNA core by doubling the reference bias current and see by how much the LNA IIP3 improves.

d. Use the following circuit to generate a reference bias current of <400µA to bias the LNA core. Assume this bias current is generated from a bandgap voltage of 0.8V and has a noise density of 55nV/sqrt(Hz). At this stage, no ideal biasing to any node of your LNA (aside from Vdd)




e. Find the 1dB desense blocker level for your LNA, assuming a blocker 10MHz away from your desired band. Note that you have to check both gain compression (PSS sim) and noise rise due to the blocker level (PSS+Pnoise) one at a time. Make sure that you do proper filtering to bias noise so that the LNA desense is not noise limited. Show plots.

f. Modify the core to implement a dual-gain LNA with High-Gain equals what you obtained in (a), and a gain step of 6dB. You can use any dual-gain topology of your choice. Simulate the corresponding S-parameters, $K_f$ and NF.

g. Tabulate your design performance obtained above. Do not forget to report also supply current.

Note: the package model and SpectreRF symbol can be found on the class bCourse under the homework section. The SpectreRF symbol file is "ee290c_pkgQFN_S2019.tar.gz", which you need to unzip using the unix command "tar –xvf ee290c_pkgQFN_S2019.tar.gz". The SpectreRF model is "pkgmodel_QFN_S2019.scs", which you need to save and include in your simulation library. Leave the "padt" node (paddle top) of the package floating. Connect a 40pH parasitic inductance from the paddle bottom to board ground (ideal ground).

p.s. It helps to document your simulation setup for your own future reference.