Problem Set 8

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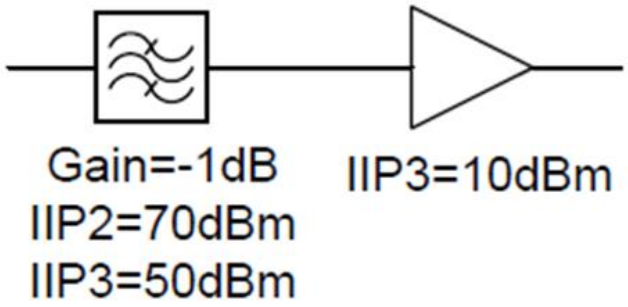
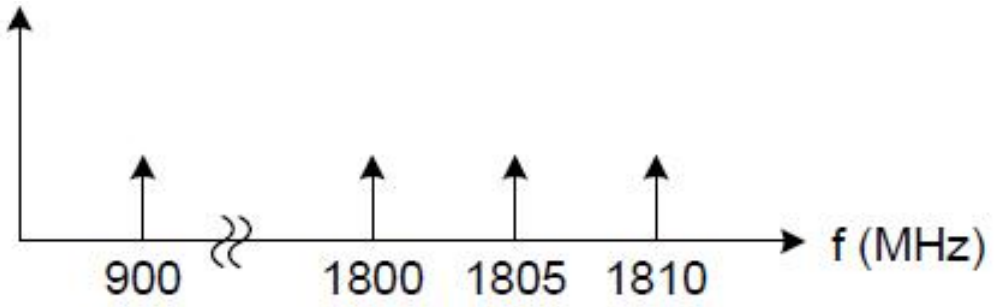
1. System Analysis

   A wireless receiver front-end is shown below:



   We would like to receive the channel at 1800MHz, while we have additional channels at 900MHz, 1805MHz and 1810MHz:

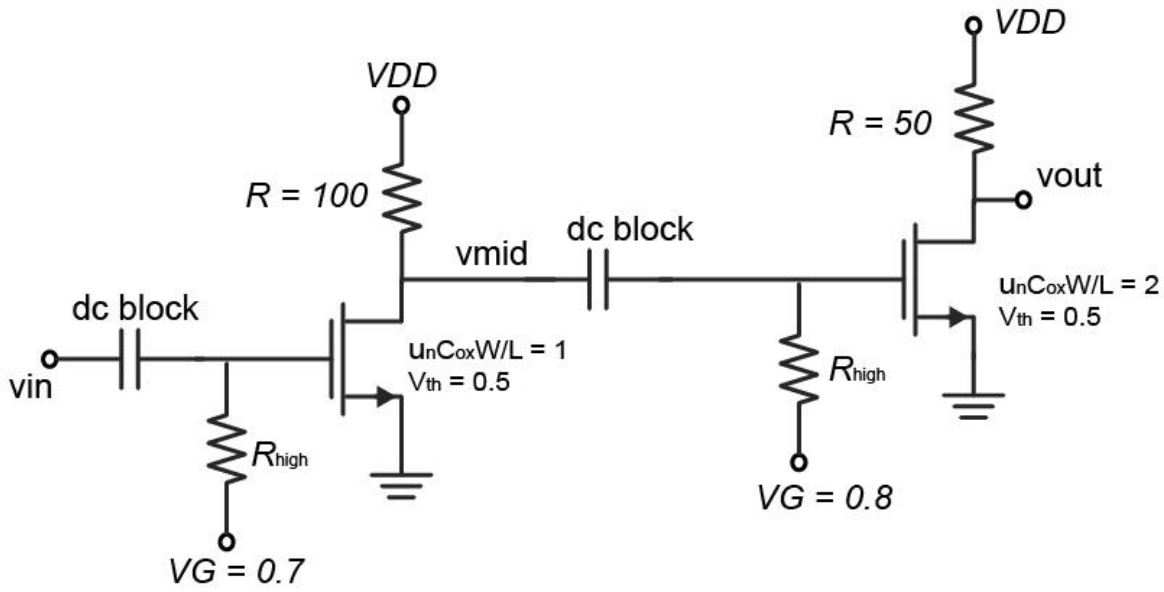


   The minimum detectable signal at 1800MHz is -100dBm. The required signal to distortion ratio at the front-end output is 9dB.

   (a) If the signal power at the 1810MHz channel is -33dBm, what is the maximum allowed power at the 1805MHz channel?

   (b) What is the required spec for the amplifier IIP2 if the signal power at the 900MHz channel can be as high as -30dBm?

2. In this problem you will do distortion analysis for a frequency-independent amplifier.



(a) For the above amplifier, derive a power series to express the small-signal output voltage (*vout*) as a function of the small-signal input voltage (*vin*). Assume the transistors are long-channel devices.

(b) Calculate IIP3 for the first stage (*vin* to *vmid*), the second stage (*vmid* to *vout*), and the overall cascade two-stage amplifier.

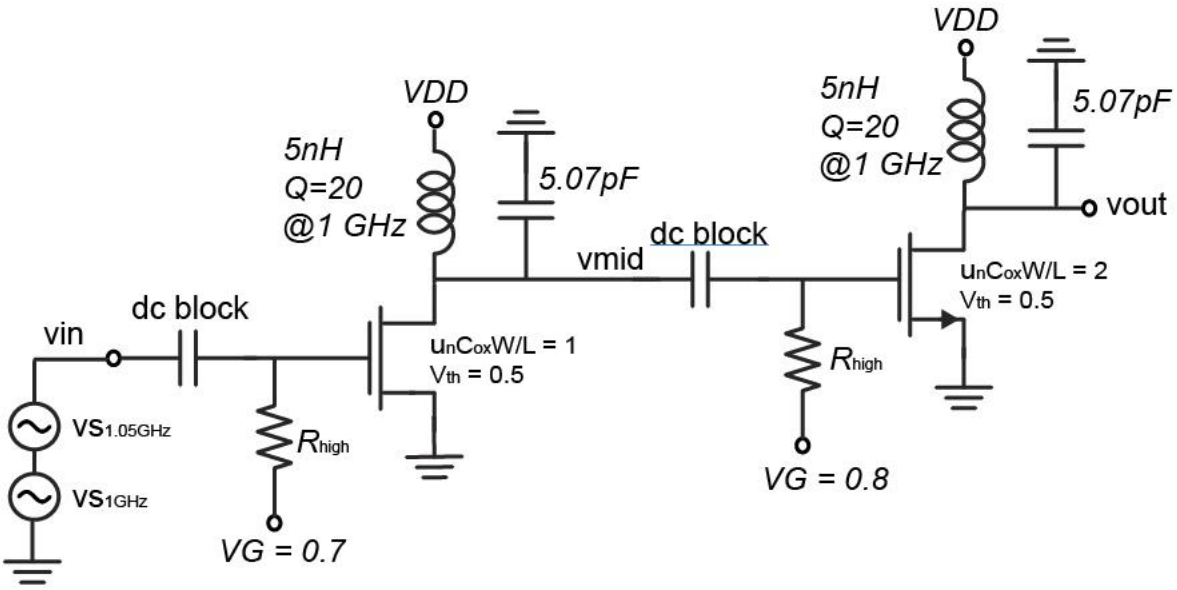
(c) Find IIP2 for the first stage, the second stage, and the cascade two-stage amplifier.

(d) Apply the cascade IIP3 and IIP2 formula introduced in the lecture. Explain if the results are different from that obtained via your analysis in part(b) and (c).

(e) Calculate HD2 and HD3 of this two-stage amplifier?

(f) Use Harmonic-balance in ADS or SpectreRF to simulation IIP2, IIP3, HD2, and HD3 of this two-stage amplifier.

3. To achieve a higher output voltage swing, the two load resistors in the previous problem are replaced by two LC-tanks, as illustrated in the below figure. Now you will do distortion analysis for a tuned amplifier. Keep in mind that in the passband of the amplifier (resonance), the memoryless assumption is valid.



(a) Under a two-tone excitation at 1.0 and 1.05 GHz with $vs_{1.0GHz} = vs_{1.05GHz} = 1$ mV (zero-to-peak voltage), estimate via hand calculation the voltage components at 0.05, 0.95, 1, 1.05, 1.10, 2.0, and 3.0 GHz, at both *vmid* and *vout*.

(b) Redo part(a) with $vs_{1.0GHz}$ reduced from 1 mV to 0.1 mV.

(c) What are the IIP3 and IIP2 of this two-stage amplifier (under this two-tone excitation at 1.0 and 1.05 GHz)? Notice that the upper-band IIP3 and IIP2 are no longer the same to the lower-band IIP3 and IIP2, respectively.

(d) Again, use ADS Harmonic-balance simulation to verify your calculated results.