Guidelines for optional simulation design report of a simple RX

This is an optional work, but your results will be taken into account for your grade on a bonus basis. Basically, a good report would make you pass the exam in case you flunk -but attend- the written exam and your grade will be increased by 1 unit if you reach a score >=4

Last year's exam was quite lengthy, so the best student did half of it. They got a grade of six. There was no optional report like the one proposed here, but I guess it's also a good way to prepare for the exam revisiting the different concepts we have studied. If you feel confident, you may as well go without spending time on this additional work.

The idea is to implement below architecture. You may choose freely the RF frequency, the IF (super-heterodyne), low-IF or 0-IF frequency (direct conversion or homodyne) and the channel bandwidth. The front-end filter should cover your band (there are a couple of ISM bands up to 2.4GHz so pick one according to your interest) and let pass all channels (it's a fixed frequency filter). Please consider the losses of the filter with realistic L Q factor (C have usually much higher Q up to a couple of GHz). Consider the component spread to make sure you do not attenuate any channel in the band by more than e.g. 0.5-1dB. Pick any of the LNAs that we have studied. You may want to use two down-conversion mixers with I-Q LO generation (ideal voltage sources). With double-balanced mixers you need differential RF signals (add a simple voltage controlled voltage source with a gain of 1 or -1) between the LNA and mixer. Alternatively, one of the mixer RF input might be tied to the DC value of the other mixer RF port. If you want to add gain along the chain, add it as a simple voltage controlled voltage source. The base-band filter should match your channel bandwidth (it's the variable LO frequency that selects which one is converted to baseband). Demonstrate how it rejects an adjacent channel using e.g. two additional tones at the input in a region where your LNA is already non-linear. You may perform FFT to get the output spectrum.

Perform mostly transient simulations and discuss about gain, compression, linearity for the LNA. Copy your schematics and simulation results in the report and discuss your choices and results. The final goal would be to use an FM modulated input (e.g. SFFM voltage source) to represent 0 and 1 (it emulates a periodic 0 and 1 sequence though the frequency transition is sinusoidal). Looking at the output signal you should be able to distinguish zeros and ones provided you have an IQ down-conversion architecture.

The report should be submitted by e-mail (david.ruffieux@epfl.ch) before the written exam.