INF5350

Obligatory exercises #2

Please submit by email latest 20-Sep-2019 to Tohid (tohidm@ifi.uio.no)

1. Write down the formula relating photon energy to its wavelength.
2. How many photons per 20msec will hit a 10x10um^2 pixel that is being illuminated with 1uW/cm^2 green light (550nm) from an LED?
3. Suppose a green LED illuminates a 10x10um pixel with 0.5uW/cm^2 and that the requirement of the sensor's responsitivity is 50V/sec on the floating diffusion node. If we assume a QE of 40%, what will CG have to be in order to achieve the responsitivity requirement? What’s the associated floating diffusion capacitance?
4. Using TSMC 65nm process, consider an NMOS source follower with Msf=1u/1u and Mcs=3u/3u, and Vdd=3V.
   1. What is the small signal ac gain formula?
   2. Adjust bias voltage of the current source device to achieve approx. 4uA bias current. What is the simulated small signal ac gain?
   3. A 10bit ADC is used to sample and digitize the pixel voltages. Input range is from 1V (0LSB) to 2V (1023LSB). What is the lowest power bias of Mcs to stay within 1LSB precision. Assume a pixel reset level of Vreset=Vdd-0.5V at the SF input. Output load and settling time constraints should be disregarded in this exercise.
   4. Using above bias, assume 2pF load at the ADC input. What is the settling time to within 1LSB precision?
   5. How large bias current is required to achieve 2us settling time to within 1LSB precision?
5. Using above SF, add a floating diffusion capacitance of Cfd=3fF and reset device of Mrst=1u/1u
   1. What is the CG?
   2. Simulate the reset operation with (i) Vdrain(Mrst)=2V and (ii) =3V. What is the rising edge settling time difference to 1LSB? You can assume that the floating diffusion (source follower input) starts at zero volt prior to the reset operation.