230A

1. We have the following 2D crystal.

(a) Find the reciprocal lattice vectors a* and b*. Draw the reciprocal lattice and specify a* and b* in your drawing. (Note: you need to specify the “length” of the a* and b* in your drawing).

(b) Draw the 1st Brillouin zone on your diagram.

230B

1. Design a 0.1 µm channel length nMOSFET with $V_{dd}=1.5$ V and $V_t=0.3$ V. The inverse slope of the subthreshold current (log scale) should be about 80 mV/decade.
   (a) What gate work function should be used?
   (b) How thick should the gate oxide be?
   (c) What should the maximum gate depletion width be?
   (d) What kind of doping profile (uniform, high-low, or low-high) should be used? Work out the doping level and depth.
   (e) What is the body effect, $dV_t/dV_{bs}$, where $V_{bs}$ is the substrate-to-source bias?

2. Consider the following chain of identical inverters with a capacitive load $C_L$ at the output of each stage. The propagation delay is 250 ps/stage for $C_L = 100$ fF. If $C_L$ is increased to 200 fF, the delay becomes 400 ps/stage. Now if the widths of both the nMOSFET and the pMOSFET of the inverters are doubled with respect to their original values, what becomes the delay per stage when $C_L$ is 100 fF?