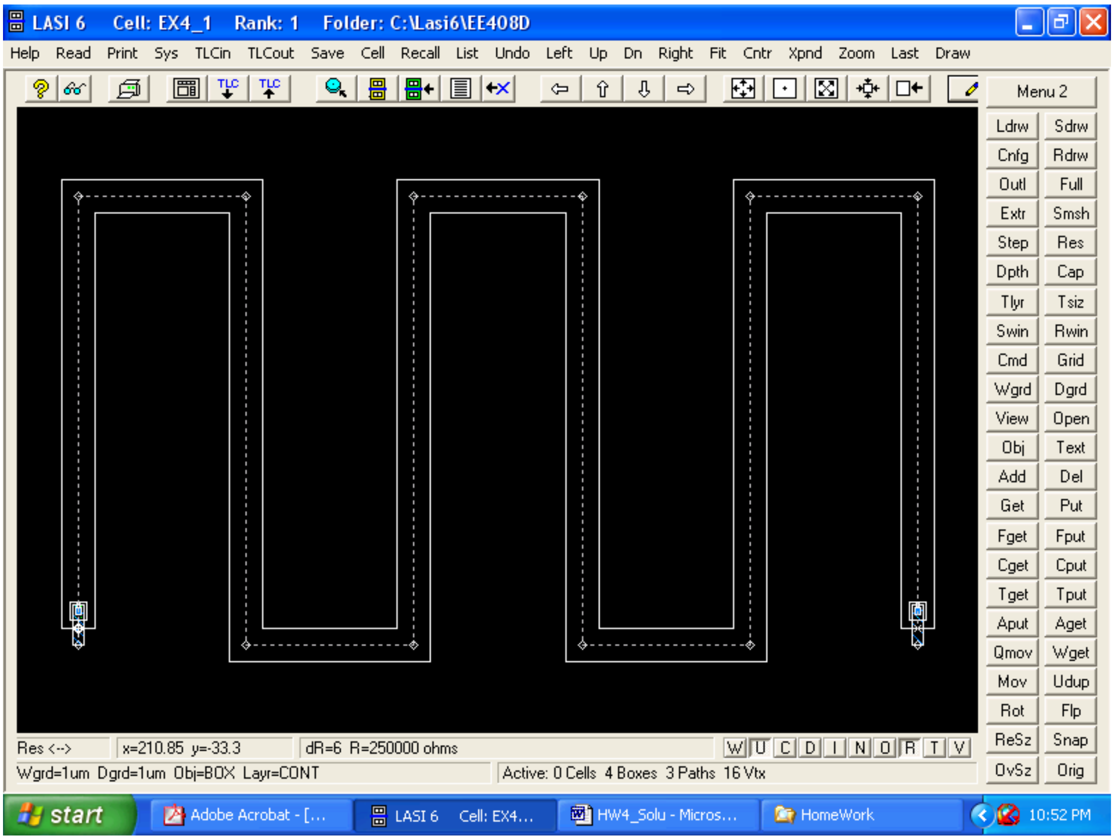
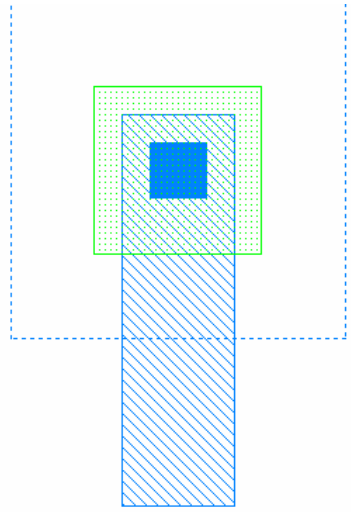
4.1

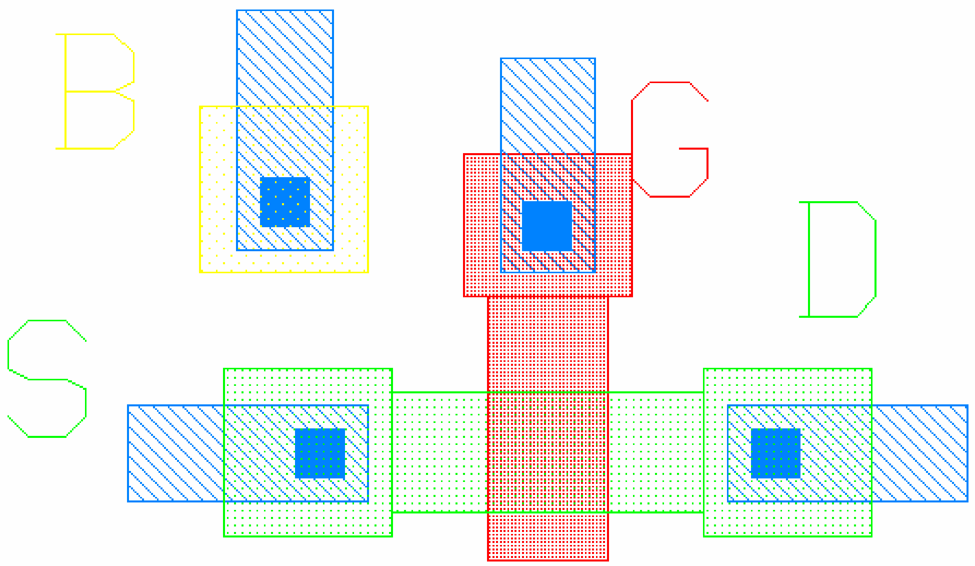
Parameters used:

n-well, Path width =12um	N+, box, size=6*6	Metal 1, path width=4, distance to n+ is 2	Contact, box, size =2*2, distance to metal is 1
0,6	-3,3	0,-6	-1,5
0,154	3,9	0,9	1,7
60,154	297,3	300,-6	299,5
60,-6	303,9	300,9	301,7
120,-6			
120,154			
180,154			
180,-6			
240,-6			
240,154			
300,154			
300,0			





If the layout did not include n+ under the contacts, a rectifying or Schottky diode is formed.



Problem 4.8

cj of n+ inplant is 1.0375×10^{-4}F/m^2, and cjsw is 2.1694×10^{-10}F/m, from page 710 and also page 77, $A_D = 10 \times 10\ \mu m^2$, $P_D = 4 \times 10\ \mu m$, therefore, the maximum capacitance, i.e. the zero bias depletion capacitance=1.0375×10^{-4}F/m^2 $\times 10 \times 10\ \mu m^2$ + 2.1694×10^{-10}F/m $\times 40\ \mu m$ =10.375 fF +8.6776 fF = **19.0526 fF.** This depletion capacitance will decrease if the n+ inplant is held at a constant potential and the substrate is reduced.

Problem 4.9

The $R = R_{square} \times L/W = 21\Omega / \square \times 1000/2 = 10.5\ k\Omega$; while $C = 100\ fF \times 1000/10 = 10\ pF$, so the delay $t = 0.35 \times 10.5k \times 10\ p =$ **36.75ns**.

Problem 4.10

The cross-sectional views of Fig. P4.10 are shown in Figure P4.10a an

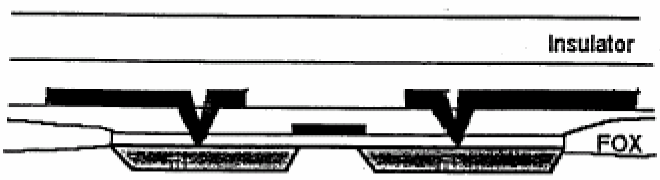


Figure P4.10a.

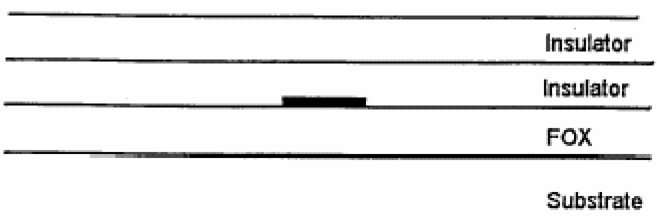


Figure P4.10b.

Problem 5.1.

Since the gate of MOSFET is connected to +2V constant voltage source by a resistor, the MOSFET will be in strong inversion. From the circuit shown in Figure P5.1, the drain, source and body of this MOSFET are all connected to ground. Hence, the MOSFET in this circuit acts as a capacitor. The capacitance is

$$C_{tot} = C'_{ox} \times W \times L = (800aF/\mu m2) \times 150\ \mu m \times 150\mu m = 18pF$$

For the 1mv AC input, the AC out

$$Vout = Vin \times (1/j2\pi fC_{tot}) / [R + (1/j2\pi fC_{tot})] = Vin / (1 + j2\pi fRC_{tot})$$

The amplitude of Vout is $1mv/[1+(2\pi \times 10MHz \times 250k\Omega \times 18pF)^2]^{0.5} \approx 0.003535mv =$ 3.535μv @ 10MHz, and the phase of this output voltage is $\tan^{-1}(-282.743) =$ **-89.8°**

Problem 5.6

From Ex 5.2, the electrostatic potential of the substrate ϕ_F is -290mV. With V_{SB}=2V, the electrostatic potential at the oxide interface $\phi_S = -\phi_F + V_{SB} = 2.29V$ @ $V_{GS} = V_{THN}$, and the depletion layer width

$$X_d = [\ 2\times 11.7\times (8.85aF/\mu m)\times (2.29+.29)V / (1.6\times 10^{-19}\times 10^{15})]^{0.5} \approx 1.83\mu m$$

The charge contains in this region is

$$Q'_b = qN_A X_d = 292.8\ aC/\mu m^2$$