EECS 105 – Microelectronic Devices and Circuits

Spring 2001, Prof. A. R. Neureuther
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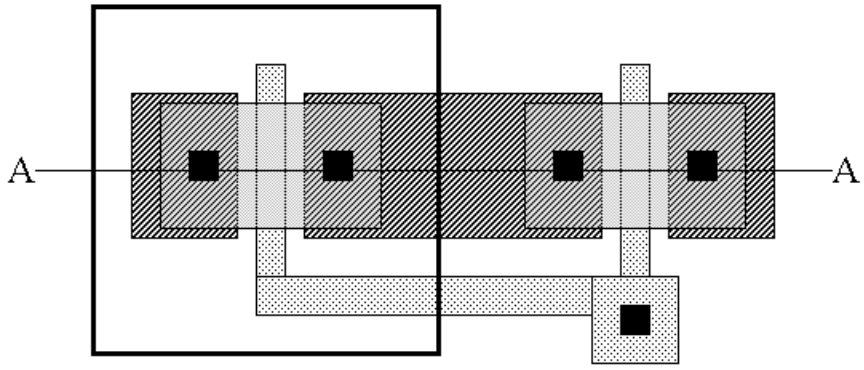
Homework Assignment # 2, Due February 2, 2001

All circuits in the following problems are fabricated in a N-well CMOS process

- oxide mask (dark field)
- polysilicon mask (clear field)
- contact mask (dark field)
- metal mask (clear field)
- N-well mask (dark field)

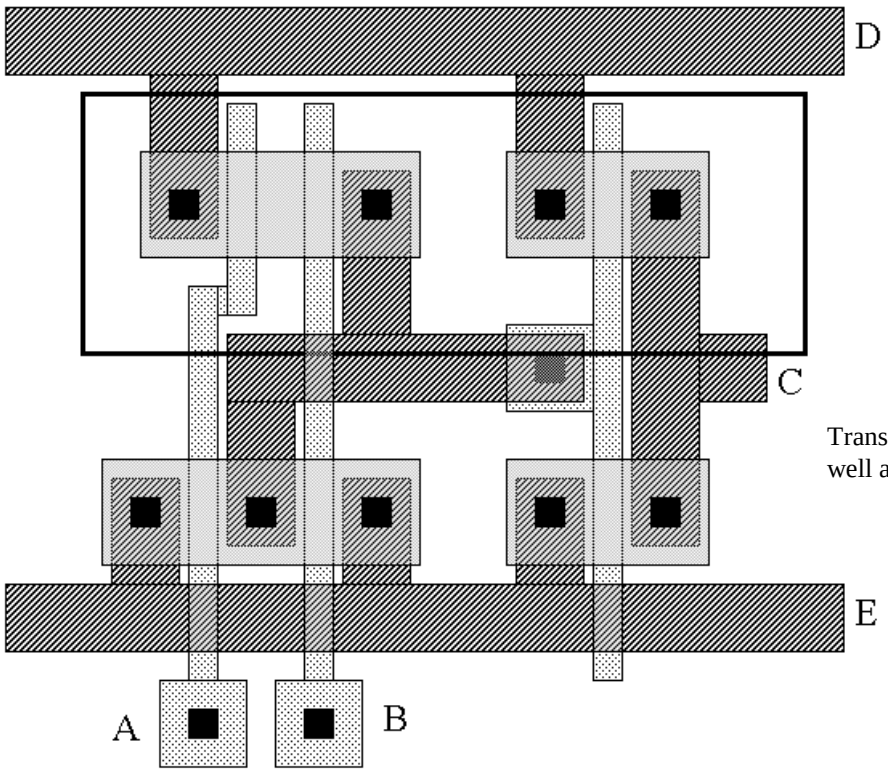
2.1 CMOS process flow. Consider the layout of a CMOS inverter. Use the 6 step process flow in Chapter 2 and add one additional mask (N-well) and two additional steps (N-well implant prior to step 1 and P-type source/drain implant prior to step 5.



a) Draw the cross section at cut-line A-A immediately after polysilicon etching
b) Draw the cross section at cut-line A-A immediately after contact opening

Specify substrate type, doping types in source/drain areas and each layer in your schematic.

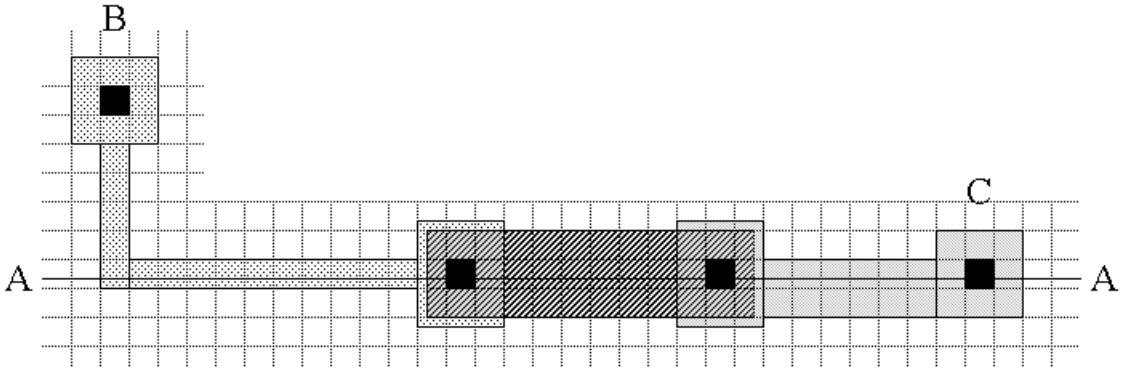
2.2 CMOS Circuit. Consider the layout of a CMOS circuit



Transistors inside the N-well are PMOS

Draw the circuit diagram (show all wirings and MOSFETs)

2.3 IC resistors. Consider the layout of an IC resistor. Assume sheet resistances of N+ doping, polysilicon and metal are 100Ω/square, 10Ω/square and 0.01Ω/square, respectively.



a) Sketch the cross section of the resistor at cut-line A-A
b) Calculate the total resistance R_{BC} (Contact and corner resistances should be considered in your calculation. Assume that the contact regions each contribute 0.65 squares)

2.4 IC resistors.

a) If the N+ doping in problem 2.3 is 0.5um deep and the distribution of dopant is uniform, find the doping concentration. (Assume the grid show on the drawing have 0.5um openings)
b) A 10kΩ resistor R_1 and a 5kΩ resistor R_2 combines in series so that their resistances add. If R_1 has an uncertainty of 500Ω and the uncertainty in R_2 is 400Ω. What is the uncertainty in R_1+R_2?