

MOT
CS

1. Fig. 1 on p. 6 shows the layout of a NOR gate fabricated in the n-well CMOS technology used in Lab 2. The layout is not complete: the n-well and p+ regions are not shown. Draw the outline of these regions on the layout, and use cross-hatching to indicate the interior of the regions. Write your name on p. 6, and hand it in with your answer book. (*Note:* In this CMOS technology, by default any region which is not covered by the p+ layer receives the n+ implant).
6 marks

2. Carefully sketch a cross-section through the integrated circuit along line X-Y (i.e., show how the IC would look if cut along line X-Y and viewed from the side). Indicate the n-well and n+ and p+ regions on your cross-section.
15 marks

3. Draw the circuit diagram corresponding to the layout of Fig. 1. Show the connection of the body (well or substrate) terminals on each transistor. Also estimate the W/L ratio for each transistor. High accuracy is not expected.
6 marks

4. The circuit of Fig. 1 is tested by shorting the inputs V_A and V_B together, and connecting them to a pulse generator. The rise and fall time of V_{OUT} is then measured in response to the input pulses. Will the rise time of V_{OUT} be greater or less than the fall time? Explain your answer. If the W/L ratio for the n-channel transistors is held fixed, how should the W/L ratio for the p-channel transistors be modified to make the rise time equal the fall time? Justify your answer. Assume $\mu_n = 2 \mu_p$ in the channel.
5 marks

5. Indicate on your circuit diagram of question 3 which transistor(s) may have their threshold voltages modified by the body effect as V_A , V_B and V_{OUT} change during normal operation of the circuit.
5 marks

6. a) The logic gate layout of Fig. 1 gives relatively poor immunity to latch-up. Explain why this is so.
5 marks

b) Suggest how the layout could be modified to greatly improve latch-up immunity. You may wish to make a sketch to illustrate your answer, but you do not need to redraw the entire layout. Explain how your modifications help resist latch-up.
5 marks