CSE464 Homework #2 Due 2005.02.09 at 4:00PM

Note: Please list at top of first sheet of homework submission anyone or anything from which you obtained any help for this homework assignment other than the text and class notes/discussion. Please give a word or two as to the nature of the help (e.g.: discussed problems, copied verbatim, whatever). Acknowledging source of help is a requirement for this assignment, and for all assignments in CSE464. It has no effect on your grade.

Note that noise margin for non-inverting circuits is simpler than for inverting circuits. For non-inverting circuits there is no tradeoff between V_{MH} and V_{ML}, they are determined independently.

1. An example of a "clever circuit" is the TI SN74ALB16244 buffer/driver. This circuit has a small propagation delay (2 ns max at 3.3V, 2 ns is small for PC board-level circuit, it would not be small for gate within an IC) but is described as using a unity-gain amplifier with feedback. Examination of the Transfer characteristics shows that Vol tracks Vil closely, and Voh is about 1V less than Vih, both with 25mA load. What are implications of this circuit for noise? Consider use of a single device, and multiple devices used in series. The data sheet is available at: www-s.ti.com/sc/psheets/scbs647d/scbs647d.pdf
2. Compare the DC characteristics (High and low logic levels and output currents) of the two logic gates whose data sheet URLs are given below. For DC only, over the range of Vdd from 1.2V to 2.5V. Is either clearly superior to the other?

   http://focus.ti.com/docs/prod/productfolder.jhtml?genericPartNumber=SN74AUC1GU04
   http://www.fairchildsemi.com/ds/NC/NC7SP04.pdf

3. Use excel or some other spreadsheet to calculate the velocity of propagation, C per meter, L per meter, and Zo for the geometries given below (parallel plate, coax, two-wires, wire over ground plane, microstrip, and stripline) for the given parameters. All dimensions are in mils (0.001 inch). A formula (approximate as most are) for microstrip and stripline Zo is given in the lecture notes on transmission line equations (Feb 02 Lecture). It may help your intuition (and help to identify gross errors) to make a scale drawing of the cross section of each configuration. Formulas that incorporate value of epsilon are given in the FUR lecture notes for Feb 02. Web based calculators are available on the UMR web pages linked to from the list of Signal Integrity Links on the EE464 home page.

   Note from the values for wire over ground plane that impedance is a very weak (ln) function of distance between the wire and ground plane. It is essentially impossible to get Zo larger than a few hundred ohms. However, as the parallel-plate example shows, it is possible to get small values of Zo. These are useful (even necessary) in power distribution for logic circuits.

	w	h	s	r1 or t	r2	eps_r	v (m/s)	Zo	C/m	L/m
Parallel-Plate	1000		5	approx 0		20				
Coax				10	40	2				
Two wires			200	25		1				
Wire over			10000	10		1				

ground plane										
Wire over ground plane			50	10		1				
wire over ground plane			10	10		1				
Microstrip	8	8		1.4		4				
Stripline	8	4 (both h1 and h2)		1.4		4				
Stripline	200	4 (both h1 and h2)		1,4		4				

4. http://www.dut.com/tools-stripline.html has an impedance calculator for stripline. What Zo is given with W of 1000 mils and the remaining parameters with a value of 1? Is this reasonable?
5. Look at: http://www.emclab.umr.edu/pcbtlc2/. Choose the calculator for microstrip trace. Note that limits are given on parameter values that would avoid problems such as those in HW Problem #4. Compare Zo calculated by formulas in the text to the UMR web page for microstrip. Use eps_r=1 (this makes all dielectric the same, a requirement for the text formulas), H=4 mils, T=1 mil, and values of W from 1 mil to 100 mils. Note that error in the text formula approaches zero as W increases.
6. Try the simple transmission-line simulator whose URL is given under the CoE464 Feb 02 links to lectures. This is a simple (and fast) simulator with limited capabilities intended for tutorial purposes. Does it perform as expected? What tests did you subject it to?
7. CSE564 Only: At the top of page 8 of Feb02 lecture notes "T-Line-Equations-Dally-Notation" is the statement: "with algebra". Show that this is true.