CSE464 Homework #5 Due 2005.03.16

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, class lecture/notes/discussion, and the instructor. 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 CoE464. It has no effect on your grade as long as you do it.

Problems 6-6, 6-13, and 6-16 from the text.
For problem 6-6, use the second line from Table 6-3, not the first line.
Problem 6-6 states that the lines are terminated in Zo, by this is meant the impedance of that line if there were no coupling (set Cm and M to zero to find Zo). In Table 6-3, C is the capacitance from one line to ground, Cm (called Cd in the notes) is the capacitance from line to line. C corresponds to Cs of Equation 6-8, and Cm corresponds to Cc of Equation 6-8.
Thus Cs (Equation 6-8), Cm (Table 6-3), and Cd (Dally notes) are all the same. Cm (Equation 6-8), C (Table 6-3), and Cc (Dally notes) are all the same. C of the Dally notes is Cc+Cd. The capacitance definitions in Table 6-3 can be verified by calculating k_cx.

In problem 6-13, Termination mismatch of 20% gives reflection (or ISI) error of approximately 20%/2 (error in Kr is approximately ½ of error in termination resistor.

1. Why is inductance more important than previously? Years ago no one worried about it except for very exceptional conditions.

Consider 74H04 inverters as available in the Bryan 316 lab. Data is given in the "High-Speed CMOS Logic Data Book", dated 1984. These devices have Vdd of 5V, rise and fall times of about 15ns, and output resistance of about 50 Ohms. Calculate the signal return crosstalk coefficient, and maximum crosstalk, if 10 of these devices drive 50 Ohm transmission lines that all share a single common ground return with 10nH of inductance. Recalculate if more modern CMOS circuits are used with rise/fall times of 0.5ns, and 50 Ohms output resistance. Use the simplest calculation by assuming that all drivers switch, and calculating the voltage across the signal return inductor divided by Vdd.

2. Consider measuring a signal with a scope probe which has fairly long ground lead. The scope probe has a 950 Ohm resistor in its tip, and 50 Ohm transmission line connection to the 50 Ohm oscilloscope input, giving 20:1 attenuation. Approximate the ground connection (from coaxial conductor outer conductor to "real" ground by a loop of #24 AWG wire (0.02 inches diameter) with 3 inch diameter. Find the inductance from UMR web site or other calculation. If the measured signal generates a 1V step with respect to "real" ground, what is measured by the oscilloscope in the first few ns? This is an interesting problem in coupled asymmetric lines (center conductor and shield of coax are two asymmetric coupled lines). For purposes of this problem, calculate the voltage

between the center conductor and the shield of the coax. Use the equivalent circuit of 50 Ohms from center conductor to shield, ground lead inductance from shield to "real" ground, and resistance from shield to "real" ground of 120 Ohms, representing the characteristic impedance of the shield to ground with the shield treated as a transmission line. The probe tip will be at signal voltage, the scope will measure the difference between center conductor and shield, so the deviation of shield voltage from zero will be measurement error. This problem illustrates why care is required in measurement of signals with short transition times.

3. According to the data sheet, the Motorola MPC948 can be used to drive twice as many loads by connecting two transmission lines, each with a series resistor, to each MPC948 output. Comment on advantages and disadvantages of this method. How would you determine whether its operation is satisfactory? Can this be expanded to drive 3 transmission lines from each output? Four transmission lines? More?

4. Read the paper by Greg Edlund article on "Anatomy of a Signal Integrity Failure": http://www.designcon.com/2003/marketing/HP5-2.pdf. Give a brief evaluation of this paper, the results, methods described, conclusions, etc. If your handwriting is average or worse please type your evaluation. FYI but not necessary for understanding the Edlund paper: GTL is "Gunning Transceiver Logic", named after the inventor: Bill Gunning of Xerox. TI has a lengthy discussion of GTL (and GTLP, P is for plus) at: http://focus.ti.com/pdfs/logic/gtlp.pdf and a lengthy comparison of bus solutions at: http://www-s.ti.com/sc/techlit/slla067. GTL is primarily designed for driving busses with many distributed loads, typically cards inserted into a backplane. The large number of closely spaced loads results in low Zo, sometimes less than 20 Ohms. From the middle of the bus, 1/2 Zo must be driven. GTL has small voltage swing to reduce power with low Zo terminations, is shunt terminated at both ends with a resistor to Vtt, and has sensitive receiver with small difference between Vih and Vil in order to increase noise margins.

5. CSE564 Only: download the ultra_ct.exe file from: http://www.ultracad.com/calc.htm and evaluate it for the case of dual stripline (two conductors between ground planes), use equal value for all four trace to ground plane dimensions. Does it seem to be correct? In particular, evaluate for the case where both ends of transmission lines are terminated.