ELEC 306
Problem Set 11
Due: November 21, 2014

Homework Problems.
Work the following problems in Sadiku:

H11.1 13.5

H11.2 13.13

H11.3 13.17

H11.4 13.30

Real Problems.

R11.1 Computation Problem. In Problem R2.1 we built a lumped parameter model of a single lossless transmission line. With a bit of work we can expand that to a model for two coupled lines, allowing us to study crosstalk. Your task in this problem is to do that work.

You may use a program such as Spice or Multisim to create a discrete component simulation, or if you prefer more of a challenge, you can formlate the PDEs and solve them numerically. If you use Spice, your model should have at least thirty sections Choose values of L and C to simulate individual lines of length 200 mm having a characteristic impedance of 50 Ω and a velocity factor of 0.6. To represent the coupling, let the mutual capacitance (C_m) be 1/20 of the capacitance to ground (C) and the mutual inductance (L_m) be 1/10 of the series inductance (L).

Note: Spice represents mutual inductance by specifying the coupling between two regular inductors. The circuit element (represented by symbol "K") is not connected to any nodes of the circuit, but rather specifies the two inductors (L_1 and L_2) which are to be coupled and their coupling coeffieient K, where $K = \frac{L_m}{\sqrt{L_1 L_2}}$.

When your model is complete, apply it to the following problems:

(a) With all lines terminated with 50Ω, test your model by applying a pulse with rise time of 0.2 ns while observing the input and output voltages of the active line. Verify that the delay and characteristic impedance are correct. If not, make appropriate adjustments before proceeding.

(b) Using the same input pulse, examine the effects of crosstalk by measuring and plotting the voltages at all four ports (active and quiet lines, near and far ends).

(c) Explore the effects of changing the risetime, both above and below the value used in the previous sections. In particular, see what happens when the risetime is greater than the delay of the line.

(d) Explore the effects of changing the coupling, both capacitive and inductive. In particular, try to verify our claim that FEXT can be eliminated by matching the capacitive and inductive coupling.

Be sure to include a printout of your model, including component values. Also include representative plots in each of the sections above.