ECE 278
Homework #6
Due Feb. 21, 2002 at the beginning of class

1) (40 pts.) In the textbook, it says that Gauss did part A of this problem when he was six years old.
A) Prove that Verdeyen equation 9.5.2 is equal to Verdeyen equation 9.5.3a. Here are some hints: First, shift the summation index so that it starts at 0. You will end up with an equation like $\sum_{m'=0}^{?}(?)$ Next, massage the equation so that it looks something like: $(?)\sum_{m'=0}^{?}\left(e^{?}\right)^{m'}$ You must determine the ? symbols for yourself. Then, use the identity that $\sum_{m=0}^{N} x^m = \frac{1-x^{N+1}}{1-x}$ (Extra credit will be given to anyone who can prove this identity.) You are almost there. Finally, use the relationship between sin(θ) and $e^{\pm i\theta}$.
B) A HeNe laser has a gain bandwidth of 1.5 GHz. If you could mode lock that laser, and the cavity length was 1 m, how many modes would lase?
C) Using a computer, plot equation 9.5.3a of Verdeyen for that case (L=1m), and for L=10 m, L= 100 m. Label your axes. The y axis will be arbitrary units, but I want real units (seconds, nanoseconds, picoseconds, whatever you think is best) for the time axis. Use the red laser line of HeNe as the central frequency. Assume all modes have the same amplitude. (You should do three separate plots). Include enough time so that you can see at least three pulses. If the pulse width is too small to see on your scale, then indicate what the pulse width is.
D) Do part B for Nd:YAG. Use 1 micron as the central lasing frequency, and 120 GHz as the gain bandwidth.
E) Do part C for Nd:YAG.
F) If you wanted to generate the shortest pulse possible, which would you choose: HeNe or Nd:YAG?

2) (15 points) Prove that the electric field given by Verdeyen equation 9.5.3a is periodic in the roundtrip transit time inside the resonator.

3) Verdeyen 9.25 (25points)

4) (20 points) Check the algebra in notes leading up to the equation for δI(t) in lecture 10, slide 72. Then write δI(ω)/δR(ω) as a function of ω using the symbols we have defined in class. Your answer will be equivalent to Verdeyen 9.3.18 but will be in terms of the symbols defined in class.

You will make the professor's life easier if you staple this sheet to the front of or back of your homework.

1	2	3	4	Total
/40	/15	/25	/20	/100