PHYS 209, 2008/09 Assignment 3

Due 5pm November 14, 2008

Turn in to the box in the hallway outside the lab.
Late assignments not accepted.

1. You are investigating the diffusion of dye molecules in a solution, and have measured dye concentration ($C(x)$) at time $t = 2$ s, as a function of position, x, as given below. Theory predicts that the concentration should follow:

$$C(x) = \frac{A_0}{(4\pi Dt)^{3/2}} e^{-x^2/4Dt}$$

Analyze the data to find A_0 and D, assuming that the errors in position, x, and time t are negligible. You should be able to find these parameters from the fit of a straight line to an appropriate plot of the data. Your answer should include an explanation of what you are plotting and why, and how you arrive your answers. Include meaningful error estimates for the parameters.

$C(x)$ (cm^{-3})	x (cm)
0.9965 ± 0.01	0.1
0.8567 ± 0.01	0.5
0.5341 ± 0.003	1.0
0.2415 ± 0.003	1.5
0.0871 ± 0.003	2.0
0.0206 ± 0.001	2.5
0.0034 ± 0.001	3.0
0.0001 ± 0.0005	3.5

2. Logic Theorems and identities

   (a) Prove DeMorgan's Theorem: $\overline{A \cdot B} = \overline{A} + \overline{B}$ and $\overline{A + B} = \overline{A} \cdot \overline{B}$ (in which "+" represents a logical OR, and "$\cdot$" represents logical AND. The proof can consist of simply verifying that the truth tables of both sides are identical.

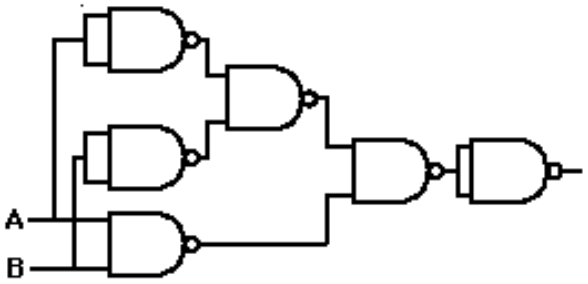
   (b) Show that $(A + B) \cdot C = A \cdot C + B \cdot C$.

   (c) Show that $A \cdot \overline{A} = 0$

   (d) Show that $A \cdot A = \mathrm{A}$

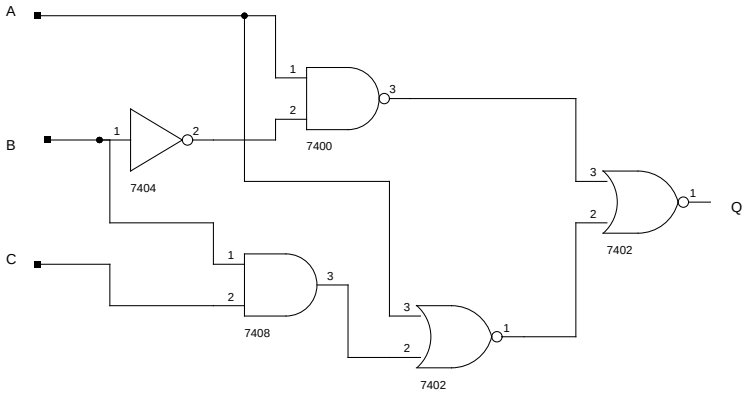
over...

3. Generate a truth table for all possible inputs (A and B) for the following circuit:



You may want to use DeMorgan's theorem and some of the other identities to simplify a logic expression that describes this circuit.

4. Consider the following circuit:



Your task is to design a simpler circuit that will produce the same truth table. You should do this by writing down a logic expression that represents Q in terms of A, B, and C and then simplifying using some of the identities you proved in question 2. This circuit can be replaced with two gates! (Where traces cross without a dot there is no connection.)