LAB MODULE 1 OF 4: LCD PIXEL : PRE-LAB QUESTIONNAIRE

NAME:_____

Fabrication and Characterization of a Liquid Crystal Display Pixel

Created for the National Science Foundation CCLI Program
(Grant No. 0633661, "Lab Teaching Modules on Organic Electronics and Liquid Crystal Displays")

Version 03 December 2008

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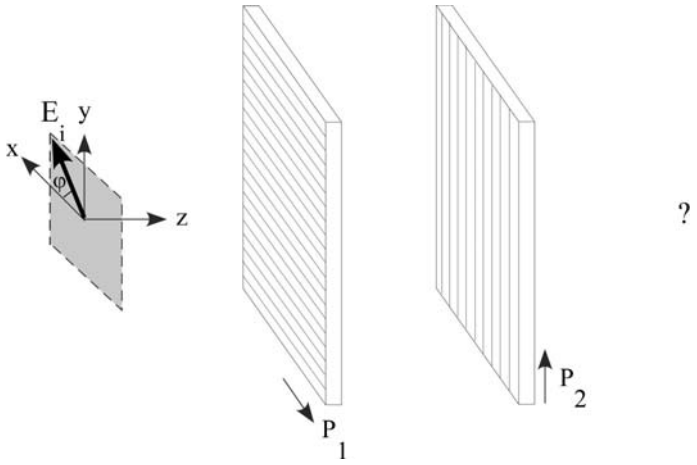
On Light Transmission through Crossed Polarizers

1. Consider the setup shown in the figure. The two polarizers shown have orthogonal transmission axes. More specifically, polarizer P_1 has its optical axis along the *X*-direction, and P_2 has its axis along the *Y*-direction.



a. A beam of linearly polarized light is incident with the electric field at an angle φ with the *X*-axis as shown (Intensity = I_0). Determine the intensity after the first polarizer as a function of the angle φ.

b. What is the intensity after the first polarizer if the light is instead unpolarized?

c. What is the intensity after crossed polarizers (90° to each other) for inputs in (a) and (b) above?

On the Transmittance of an LCD Pixel

2. An approximate expression describing the Transmittance (*T*) through an LCD pixel is given by the equation at right. Here *u* is given by $u = 2\Delta nd/\lambda$, where Δn is the birefringence of the liquid crystal material, *d* is the cell thickness, and λ is the wavelength of operation. Find the plot of *T* in the lab manual or in the Lecture Slides.

$$T = \frac{1}{2} - \frac{1}{2}\frac{\sin^2\left(\frac{\pi}{2}\sqrt{1+u^2}\right)}{1+u^2}$$

a. From this graph, estimate the Δn required to achieve a minimum transmittance, T.

b. List the first three values of u for which T reaches the maximum value.

c. Given the thickness d = 6 μm, find the first three lowest values of birefringence, Δn, that would be optimum for a wavelength of λ = 625 nm.

On Efficiencies in Commercial Laptop/Desktop Liquid Crystal Displays

3. The illustration below shows the primary layers of a common design for an LCD suitable for desktop monitors. Notice that the maximum transmittance, T, is given for each layer, assuming the pixel is ON, and assuming that the input light is broadband (i.e. white light). Use these numbers to estimate the optical efficiency (or overall optical transmittance) of this conventional LCD.

Note that the CCFL stands for cold-cathode-flourescent-lamp (the actual light source in most LCDs). Also note that the illustration is not drawn to scale.