

EE119 Discussion Section 9

(04/05/10)

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1. Photodiode – review on p-n junction, depletion region, bias; charge carrier transport – diffusion and drift; pn photodiode vs. pin photodiode

For a particular PIN photodiode, a pulse of light containing 5×10^{12} incident photons at wavelength of $1.55 \mu\text{m}$ gives rise to, on average, 1.5×10^{12} electrons collected at the terminals of the device.

- What is the energy incident to the photodiode? What is the quantum efficiency of the photodiode?
- The diffusion length is 0.5mm in this detector. If the electron diffusion velocity is $7 \times 10^6 \text{cm/s}$, estimate the response time of the detector. (Do not take drift into account.)
- The thickness of the intrinsic layer in the photodiode is typically about 2.5mm . If the drift velocity of the electrons in this region is 10^7cm/s , estimate the response time of the detector. (Do not take diffusion into account).

2. LCD – birefringence in nematic liquid crystal; (super) twisted nematic liquid crystal; electro-optic response of a TN/STN LC cell.

(a) E7 is a nematic liquid crystal with $n_o=1.52$ and $n_e=1.75$ at $\lambda=577 \text{nm}$. Find the half-wave-plate thickness at this wavelength.

(b) When there is no electric field, a twisted nematic liquid crystal produces a 90° shift in the polarization of light passing through. One can model the layers of twisted nematic liquid crystal as a stack of Polaroid sheets with each of its transmission axis slightly deviate (by an angle of θ) from the one above. With $\theta = 1^\circ, 0.5^\circ$, what is the transmitted light intensity compared to that before passing through the liquid crystal?

(c) Given an electro-optic response of a TN/STN LC cell, what is the maximum allowable change in pixel voltage for a 6 bit gray scale display?

3. Lasers – laser threshold condition; steady state condition.

- Write down the equation for steady state laser oscillation.
- If two mirrors have 0.95 and 0.99 reflectivity for a cavity laser, what's the gain?
- If the gain coefficient (g) of the laser material is known to be $0.005/\text{cm}$, how far apart should the mirrors be placed?