## ELEC-E3210 Optoelectronics Feb 14, 2019

**Exercise 5: Photodetectors**

1. We consider a GaAs-pin-photodiode, with an intrinsic layer thickness of 1.0 μm and a surface area of $10^{-4}$ cm$^2$. The detector is illuminated at a wavelength of 775 nm with a light intensity of 0.1 W cm$^{-2}$. The absorption coefficient of the active region is $10^4$ cm$^{-1}$ at the wavelength of interest. Calculate the induced current under the assumption that photons are absorbed only in the active region.

2. Estimate the bandwidth of a GaAs pin-photodiode, when the detector surface is 1 mm$^2$ and the thickness of the active region is 1.0 μm. The dielectric constant of GaAs is 12.3, the saturation velocity for holes is $3\times10^6$ cm/s and the detector load is 50 Ω.

3. The active region of a p-i-n-fotodiode (silicon) is circular in shape with a diameter of 0.4 mm. At the wavelength of 700 nm and intensity 0.1 mW/cm$^2$ light induces a 56.6 nA current. Calculate the responsivity of the photodiode and the quantum efficiency at this wavelength.

4. A pin-photodiode has a responsivity of 0.6 A/W at a wavelength of 0.8 $\mu$m. The dark current value is 1 nA, the bandwidth is 10 MHz and the load resistance is 100 Ω. a) Calculate the signal-to-noise ratio when the input optical signal has a power of 1.0 $\mu$W. b) What is the NEP of the detector?

5. The quantum efficiency of an InGaAsP/InP avalanche detector is 0.8 at a wavelength of 1.3 $\mu$m. When the detector is illuminated with a power if 1.0 $\mu$W, a current of 20 $\mu$A is measured from the detector. The thickness of the multiplication region is 1.5 $\mu$m. a) What is the multiplication coefficient of the photodiode? b) How large is the ionisation coefficient if we suppose that only electrons multiply themselves?