HW #8

No Due Date

1. A p-i-n photodiode has an absorption coefficient of 10^4 cm^{-1}. The surface of the photodiode is AR-coated to allow 100% transmission. Assume the internal quantum efficiency of the absorption layer is 90%. The photodetector is connected to a 50Ω impedance. The electron velocity is 10^7 cm/sec, and the hole velocity is $2x10^6$ cm/sec.
    a. To achieve a total quantum efficiency of 80%, how thick should the absorption layer be?
    b. What is the maximum possible bandwidth that could be achieved by the design in (a)? What is the condition to achieve the maximum bandwidth?

2. A SAM-APD has a 2-μm long absorption region and a 0.5-μm long multiplication region. The absorption coefficient of the absorption region is 10^4 cm^{-1}, while the multiplication region is made of a wide-bandgap material with an electron impact ionization coefficient of 5×10^4 cm^{-1} and a hole impact ionization coefficient of 5×10^3 cm^{-1}. The surface of the APD is anti-reflection coated so the reflection is 0%. The electron velocity is 10^7 cm/sec, and the hole velocity is $2x10^6$ cm/sec.
    a. What is the responsivity of the APD for 1.55-μm light? (Note: responsivity includes the effect of gain).
    b. What is the bandwidth of the APD?
    c. What is the noise figure of the APD?
    d. What is the receiver sensitivity (defined as the minimum received optical power to reach a signal-to-noise ratio of 1000) of the APD at 1 Gbit/sec? Express your answer in dBm. The APD is connected to a 50Ω resistor.