EE 230 Fall 2002

Homework #5

Due: Thursday Nov. 14, in Class.

Read: 4.1, 4.2, 4.3*, 4.4, 4.5, 4.6*, 4.7*

Problems:

1. Calculate the responsivity of a p-i-n photodiode at 1.3 and 1.55 µm if the quantum efficiency is 80%. Why is the photodiode more responsive at 1.55 µm?

2. Photons at a rate of 10^{10}/s are incident on an APD with responsivity of 6 A/W. Calculate the quantum efficiency and the photo-current at the operating wavelength of 1.5 µm for an APD gain of 10.

3. Consider a 0.8 µm receiver with a silicon p-i-n photodiode. Assume 20 MHz bandwidth, 65% quantum efficiency, 1 nA dark current, 8 pF junction capacitance, and 3 dB amplifier noise figure. The receiver is illuminated with 5 µW of optical power. Calculate the rms noise currents due to shot noise, and amplifier noise. Also determine the SNR. (Hint: Use $T=300$ K and $\Delta f = \frac{1}{2\pi R_L C}$)

4. Derive an expression for the optimum value of M for which the SNR becomes maximum by using $F_A(M) = M^x$ in

$$SNR = \frac{(MRP_m)^2}{2qM^2F_A(RP_{in} + I_d)\Delta f + 4(k_B T / R_L)F_a \Delta f}$$

5. A 1.3 µm digital receiver is operating at 1Gb/s and has an effective noise bandwidth of 60 MHz. The p-i-n photodiode has negligible dark current and 90% quantum efficiency. The load resistance is 100 Ω and the amplifier noise figure is 3 dB. Calculate the receiver sensitivity corresponding to a BER of $10^{-9}$. How much does it change if the receiver is designed to operate reliably up to a BER of $10^{-12}$?