

Opto-Electronics IV Q9.6/7/8

$$\eta := .65 \quad \lambda := 0.8 \cdot 10^{-6} \cdot \text{m}$$

$$c := 2.998 \cdot 10^8 \cdot \frac{\text{m}}{\text{s}}$$

$$e := 1.602 \cdot 10^{-19} \cdot \text{C}$$

$$h := 6.626 \cdot 10^{-34} \cdot \text{J} \cdot \text{s}$$

Q9.6 :

a) Mean photocurrent:

$$P_0 := 5 \cdot 10^{-6} \cdot \text{W}$$

$$R := \frac{\eta \cdot e \cdot \lambda}{h \cdot c} \quad R = 0.419 \frac{\text{A}}{\text{W}}$$

$$I_p := R \cdot P_0$$

$$I_p = 2.097 \times 10^{-6} \text{ A}$$

b)

$$B := 20 \cdot \text{MHz}$$

$$i_{\text{qn}} := 2 \cdot e \cdot I_p \cdot B$$

$$i_{\text{qn}} = 13.436 \text{E-}018 \text{ A}^2$$

$$I_{\text{qn_rms}} := i_{\text{qn}}^{\frac{1}{2}}$$

$$I_{\text{qn_rms}} = 3.666 \times 10^{-9} \text{ A}$$

c)

$$\text{SNR} := 10 \cdot \log \left(\frac{I_p^2}{i_{\text{qn}}} \right)$$

$$\text{SNR} = 55.1 \text{ dB}$$

Q9.7:

$$C_d := 8\text{pF}$$

a)

$$\text{Bolt} := 1.381 \cdot 10^{-23} \cdot \frac{\text{joule}}{\text{K}}$$

$$R_L := \frac{1}{2 \cdot \pi \cdot C_d \cdot B}$$

$$T := 300 \cdot \text{K}$$

$$R_L = 994.7 \Omega$$

$$R_d := R_L$$

$$\text{b) } I_{\text{tn_rms}} := \left(\frac{4 \text{Bolt} \cdot T \cdot B}{R_L} \right)^{\frac{1}{2}}$$

$$I_{\text{tn_rms}} = 1.825 \times 10^{-8} \text{ A}$$

$$\text{c) } I_D := 1 \cdot 10^{-9} \cdot \text{A}$$

$$\text{SNR2} := \frac{I_p^2}{2 \cdot e \cdot B \cdot (I_p + I_D) + \left(\frac{4 \text{Bolt} \cdot T \cdot B}{R_L} \right)}$$

$$\text{SNR2} = 1.268 \times 10^4$$

$$\text{SNR} := 10 \log(\text{SNR2})$$

$$\text{SNR} = 41.032$$

Q9.8:

$$F_n := 2 \text{ dB} \quad C_a := 7 \text{ pF}$$

$$B := 20 \text{ MHz}$$

a)

$$C_T := C_d + C_a$$

$$C_T = 1.5 \times 10^{-11} \text{ F}$$

$$R_T := \frac{1}{2 \cdot \pi \cdot C_T \cdot B}$$

$$R_T = 530.516 \Omega$$

$$R_a := \frac{-R_T \cdot R_d}{R_T - R_d}$$

$$R_a = 1.137 \times 10^3 \Omega$$

b)

$$\text{SNR}_{\text{dB}} := 50$$

$$\text{SNR} := 10^{\frac{\text{SNR}_{\text{dB}}}{10}}$$

$$\text{SNR} = 1 \times 10^5$$

Assume that the receiver is thermal noise limited (PIN)

$$I_p := \left[\text{SNR} \cdot \frac{(4 \text{ Bolt} \cdot T \cdot B \cdot F_n)}{R_L} \right]^{\frac{1}{2}}$$

$$I_p = 8.163 \times 10^{-6} \text{ A}$$

$$P := \frac{I_p^2}{R}$$

$$P = 1.947 \times 10^{-5} \text{ W}$$