

Exercise 9 - Solution

Task 9.1

1. A semiconductor (for example of group IV) is doped, when a group of lattice atoms is replaced by a atoms of a higher or lower (group III or V) lattice atoms. Lower lattice atoms are called donors, higher lattice atoms are called acceptors.
2. The band gap is the difference in energy in a substance between electron orbitals in which the electrons are not free to move (the valence band) and orbitals in which they are relatively free and will carry a current (the conduction band).

Task 9.2

given: $k = 1.38 \cdot 10^{-23} \frac{Ws}{K}$, $T = 25K$, $B = 1Hz$, $\eta = 60\%$, $d_1 = 12m$ $d_2 = 3m$, $\lambda = 10cm$, $P_{tr} = 5W$

1.

$$N = kTB = 3.45 \cdot 10^{-22}W = -214.62dBW = -184.62dBm$$

2.

$$A_{eff,rec} = \eta \cdot \pi \cdot \frac{d_1^2}{4} = 67.86m^2$$

3.

$$A_{eff,tr} = \eta \cdot \pi \cdot \frac{d_2^2}{4} = 4.24m^2$$

$$G_{tr} = A_{eff,tr} \cdot \frac{4\pi}{\lambda^2} = 5328.14 = 37.27dBi$$

4.

$$\frac{S}{N} = 1 \Rightarrow S = N = P_{rec}$$

$$P_{rec} = P_{tr} \cdot G_{tr} \cdot \frac{A_{eff,rec}}{4\pi R^2}$$

$$\Rightarrow R = \sqrt{\frac{P_{tr} \cdot G_{tr} \cdot A_{eff,rec}}{4\pi N}} = 2.04 \cdot 10^{13}m = 2.04 \cdot 10^{10}km$$

Task 9.3

$$P_a = 19dBW = 79.43W$$

$$P_b = (P_a + 53 - 220 + (-3))dBW = -151dBW = 7.9 \cdot 10^{-16}W$$

$$P_c = (P_a - 3)dBW = -154dBW = 3.98 \cdot 10^{-16}W$$

$$L[dB] = 92.4 + 20\log(F) + 20\log(d) \Rightarrow d = 1,199,416.45km$$