Exercise 8 - Solution

Task 8.1

series conduction:

$$\sigma_{tot} = \frac{1}{\frac{1}{\sigma_1} + \frac{1}{\sigma_2} + \frac{1}{\sigma_3}}$$

$$\sigma_1 = \frac{L_1}{K_1 A_c}, \sigma_2 = \frac{1}{\alpha_c A_c}, \sigma_3 = \frac{L_2}{K_2 A_{eff}}$$

$$\Rightarrow \sigma_{tot} = 0.834 \frac{W}{K}$$

$$Q = \sigma_{tot}(T_{box} - T_2) \Rightarrow T_{Box} = \frac{Q}{\sigma_{tot}} + T_2 = 30.02°C$$

Task 8.2

given: $f = 2GHz$, $r = \frac{880}{221}$, $v = 10\frac{km}{s}$, $d_{rate} = 10\frac{kbit}{s}$, $c = 3 \cdot 10^8 \frac{m}{s}$, $f_c = 150kHz$

1.

- distance is increasing:

$$\Delta f_{up} = -\frac{f \cdot v}{c} = -66.67kHz$$

- distance is decreasing:

$$\Delta f_{down} = -\frac{(f + f_{up}) \cdot v \cdot r}{c} = -265.45kHz$$

2.

- Doppler shift on received downlink subcarrier:

$$\Delta f_{sub} = -\frac{v \cdot f_c}{c} = -5Hz$$

- Doppler shift on the TM data rate:

$$\Delta f_{dop} = -\frac{v \cdot d_{rate}}{c} = -0.33\frac{bit}{s}$$

3.

The shape of the transmitted rectangular TM bit stream does not change, it is still rectangular. However, the frequency changes.

Task 8.3

1.

The difference between high gain and low gain antenna is the respective beam width. A high gain antenna has a focused, narrow radiowave beam width, while a low gain antenna has a broad radiowave beam width.

2.

A satellite has both a high gain and a low gain antenna for failure reasons. Normally the high gain antenna is used for the primary link while the low gain antenna is used as a backup.

3.

Low gain antennas should be distributed on the space craft in a way, that they cover as many directions as possible. If for example a spacecraft has only two low gain antennas, they should be placed on opposite sides of the spacecraft.