Exercise 11 - Solution

Task 11.1

1.

$$T_{ecl} = 0.25 \cdot 80min = 20min = 0.3h$$

$$P_{ecl} = 900W \cdot 0.3h = 300Wh$$

minimum size of battery:

$$C_{bat} = \frac{300Wh}{0.4 \cdot 0.9} = 833.3Wh$$

$$C_{bat}[Ah] = \frac{833.3Wh}{28V} = 29.76Ah$$

2.

$$P_{charge} = \frac{300Wh}{0.9 \cdot 28V} = 11.9Ah$$

$$P_{charge_{max}} = \frac{29.76Ah}{2} = 14.88Ah$$

$$\Rightarrow P_{charge} \leq \frac{C_{bat}}{2}$$

$$I_{charge} = \frac{P_{charge_{max}}}{80min - 20min} = 14.88A$$

3. battery cells in series:

$$\text{number of cells in series} = \frac{28V}{1.2V} = 23.33 \approx 24$$

battery cells in parallel:

$$\text{number of cells in parallel} = \frac{C_{bat}[Ah]}{C_{cell}} = \frac{29.76Ah}{2400mAh} = 12.4 \approx 13$$

total number of cells: number of cells in series $\times$ number of cells in parallel

$$24 \cdot 13 = 312$$

4. current of battery during eclipse (discharge)

$$I_{ecl} = \frac{900W}{28V} = 32.14A$$

limit of current of one cell (discharge)

$$\frac{C_{cell}}{2} = 1200mA = I_{cell}$$

$$\text{number of cells in parallel} = \frac{I_{ecl}}{I_{cell}} = 26.78 \approx 27$$

total number of cells:

$$24 \cdot 27 = 648$$

Task 11.2

1. resolution: $640 \cdot 480 = 307,200\text{pixel}$
   data volume for one image: $307,200 \cdot 8\text{bit} = 2,457,600\text{bit}$
   four pictures a day:

   $$2,457,600\text{bit} \cdot 4 = 9830400\text{bit} = 1,228,800\text{byte (payload memory size)}$$

   data volume for housekeeping

   $$10 \cdot 8\text{bit} + 16\text{bit} = 96\text{bit}$$

   number of orbits per day

   $$\frac{1440min}{94min} \approx 15 \text{ orbits per day}$$

   duration of offline operations:

   $$95min \cdot 13 + 85min \cdot 2 = 1405min$$

   duration of online operation: 20min
   total number of housekeeping records:

   $$\frac{20min \cdot 60\frac{s}{min}}{2s} + \frac{1405min \cdot 60\frac{s}{min}}{30s} = 3410$$

   total data volume for housekeepings

   $$3410 \cdot 96\text{bit} = 327,360\text{bit} = 40,920\text{byte}$$

   total memory size

   $$(1,228,800 + 40,920)\text{byte} = 1269720\text{Byte} = 1270\text{kbyte}$$

2. required data rate

   $$\frac{\text{memory size}}{\text{contact duration}} = \frac{1269720\text{Byte}}{20min \cdot 60\frac{s}{min}} = 1058.1\frac{\text{byte}}{s} = 8.5\frac{\text{kbit}}{s}$$

3. $$A_{sa} = \frac{P_{sa}}{P_{EOL}} = 2.82m^2$$

4. capacity in Wh

   $$C_r = \frac{P_e \cdot T_e}{DoD \cdot N \cdot \eta} = 203.7Wh$$

   capacity in Ah

   $$C_r = \frac{203.7Wh}{27.1V} = 7.52Ah$$