1. Consider the following data set:

<table>
<thead>
<tr>
<th>x[m]</th>
<th>-4</th>
<th>-2</th>
<th>0</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>y[m]</td>
<td>2.1</td>
<td>2.4</td>
<td>2.5</td>
<td>3.5</td>
</tr>
<tr>
<td>σ_y[m]</td>
<td>0.2</td>
<td>0.2</td>
<td>0.5</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Uncertainties on y, σ_y are statistical, gaussian and uncorrelated. Uncertainties on x can be neglected.

a) Fit a straight line y=a+bx. What are the values of the parameters a and b and their uncertainties.

b) What is S_min corresponding to the best line, and S_min/ndf (ndf = number of degree of freedom).

c) How good is the fit?

Use Excel and gnuplot, and attach corresponding data sheets, calculations and plots.
2. Consider a decaying radioactive source whose activity is measured at intervals of 30 seconds. The total counts during each period are given below:

<table>
<thead>
<tr>
<th>t[s]</th>
<th>1</th>
<th>30</th>
<th>60</th>
<th>90</th>
<th>120</th>
<th>150</th>
<th>180</th>
<th>210</th>
<th>240</th>
<th>270</th>
</tr>
</thead>
<tbody>
<tr>
<td>N[counts]</td>
<td>106</td>
<td>80</td>
<td>98</td>
<td>75</td>
<td>74</td>
<td>73</td>
<td>49</td>
<td>38</td>
<td>37</td>
<td>22</td>
</tr>
</tbody>
</table>

a) What is the lifetime $\tau$ of this source, assuming:

$$N(t) = N_0 \exp(-t/\tau)$$ (no background counts).

b) What is the uncertainty on $\tau$?

**Hint:** Use the Least Squares Method and error propagation. Assume:

$$\sigma_{N_i} = \sqrt{N_i}$$

Use Excel and gnuplot, and attach corresponding data sheets, calculations and plots.
3. Frame S’ has a speed \( v=\text{const} \) (y direction) relative to frame S. Clocks are adjusted so that \( t=t'=0 \) at \( y=y'=0 \). Two events occur in S frame:

- Event P1: \( y_1=-10\text{m} \) and \( t_1=10^{-5}\text{s} \) (\( x_1=0, z_1=0 \))
- Event P2: \( y_2=50\text{m} \) and \( t_2=5\times10^{-6}\text{s} \) (\( x_2=0, z_2=0 \))

a) Draw both frames S and S’ and mark events P1 and P2 in S and S’.

b) Calculate the position and time difference between events P1 and P2 as measured in a) frame S and b) in frame S’ assuming:

i) \( v=10^{-3}\text{c} \)

ii) \( v=0.5\text{c} \)

Interpret the results. Use Galilean transformations in i) and Lorentz transformations in ii).