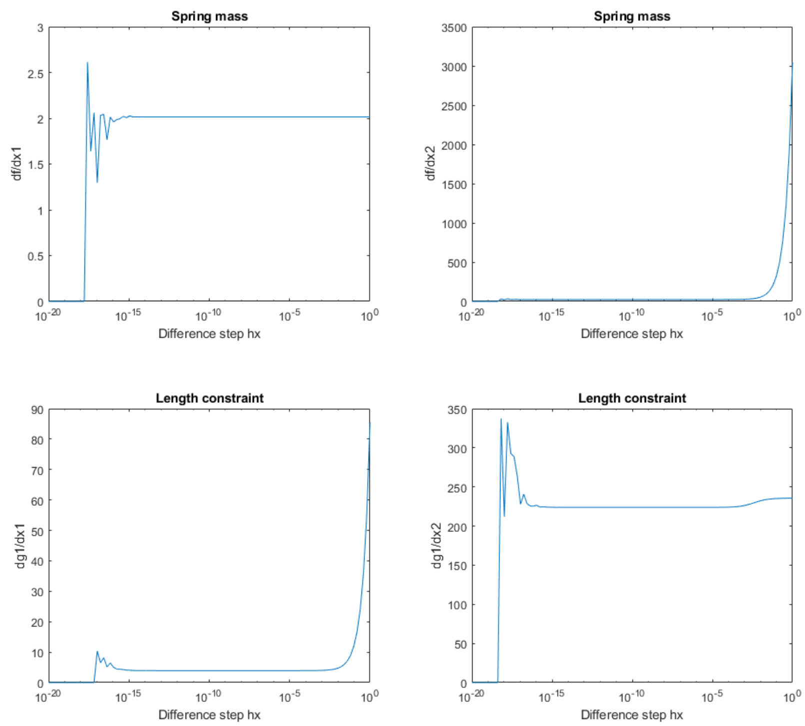
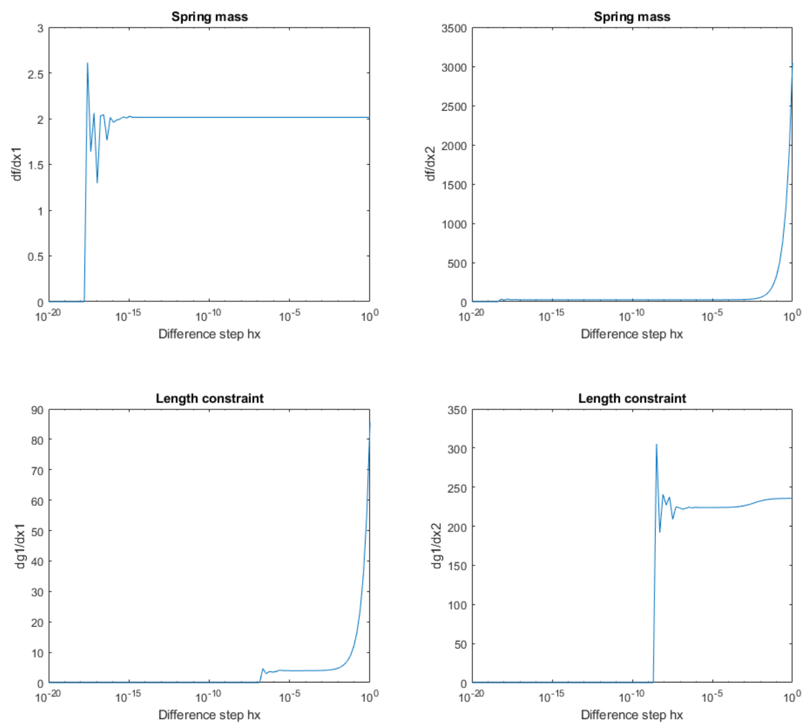
Exercise 5.1

For the design point x = [0.024, 0.004] the gradients of the objective function and constraint one are plotted as a function of the step size in the figure below:



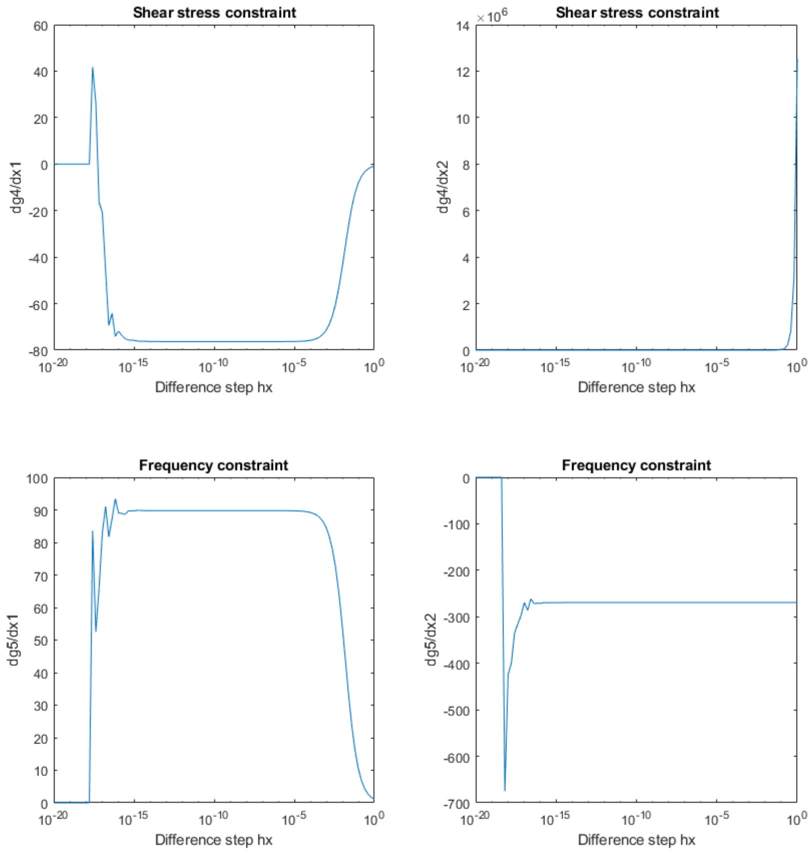
It is clear that not all step sizes are usable for calculating the gradient. For example, for step sizes below 1e-15, the gradients are smaller than the standard numerical precision of Matlab, thus the resulting gradient is just noise (condition error). On the other side of the plot, it is noticed that a step size larger than 1e-4 is also not feasible, as the derivatives become too large to be credible. This is a cuased by ignoring the higher order terms when calculating the first order forward finite diffe rence (truncation error). The resulting feasible range for the step size is between these two regions, thus between 1e-15 and 1e-4.

After rounding g1 to 5 digits instead of 16, the following plot is generated:



In the bottom two plots, it is clear that the feasible range for the step size has been reduced considerably by the rounding: only step sizes between 1e-6 and 1e-4 are feasible. The condition error also moves to larger step sizes, now the numerical error is caused primarily by the rounding.

The gradients of the constraints g4 and g5 are plotted as well in the Figure below:



From this plot, it is observed that again the step sizes below 1e-15 are not feasible as it is just numerical noise. Again, step sizes larger than 1e-4 are also not feasible. This range thus corresponds well to the step size range of constraint 1.

Exercise 5.2

To check the KKT for **x*** the linear system of equations $\overline{\nabla g} \cdot \overline{\mu} = -\nabla f$, where $\overline{\nabla g}$ and $\overline{\mu}$ are the gradients and Lagrange multipliers for the active constraint, is solved (using linsolve in Matlab). This retuned $\overline{\mu} = [0.0348 \;\; 0 \;\; 0.0613]^T$. Since the multiplier is 0 for in active constraints all the Lagrange multipliers are greater or equal to zero, so the KKT condition is met. So, **x*** is a local constraint minimum.

For x = [0.02462 0.004035], the intersection of g1, g2 and g3, $\overline{\mu} = [-0.1631 \;\; -0.0115 \;\; 0]^T$. Not all Lagrange multipliers are greater than zero so KKT condition is not met. This point is no local minimum.

For x = [0.022251 0.004075], the intersection of g1 and g4, $\overline{\mu} = [-0.1231 \;\; 0.0164]^T$. Not all Lagrange multipliers are greater than zero so KKT condition is not met. This point is not a local minimum.