3. OSCILLATIONS (7 points) — *Lasse Frantti.*

i) *(2 points)* A steel ball (mass $m = 1\,\text{kg}$) is attached to an ideal vertical spring. This causes the spring to lengthen by $x = 5\,\text{cm}$. The ball is then pulled down by $s = 10\,\text{cm}$ from its equilibrium point and released, which leads to an oscillation. What should be the length of a point mass pendulum in order to have the same small oscillations period as this system?

ii) *(2 points)* A hole is drilled diametrically through a spherical asteroid. An astronaut drops a stone into the hole to see what happens. Show that the stone starts to oscillate harmonically back and forth in the hole.

iii) *(2 points)* You want to send a parcel to your friend at the other end of the drilled hole. You can either throw the parcel horizontally (around the asteroid) or drop it into the hole. Which way is faster?

iv) *(1 point)* A perfectly elastic ball is dropped onto a horizontal table from height $h = 50\,\text{cm}$. Estimate the period of bounces. Is this motion a simple harmonic oscillation? Why/why not?