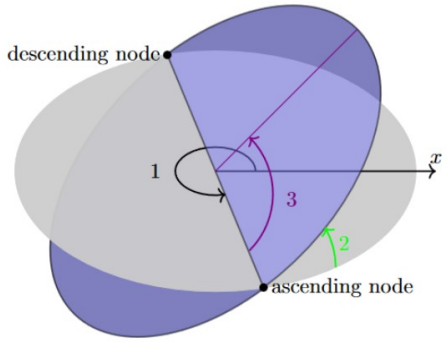
# Tutorial Sheet 1
# Physics

**Hint:** These exercises were created by the tutors for the tutorials. They are neither relevant nor irrelevant for the exam. The evaluation of the difficulty corresponds to the assessment of the tutors.

**Exercise T1.1** *(Mr. Cheap)*
Mr. Cheap started working at NASA and is tasked with cutting costs. He got the idea to replace the expensive atomic clocks on the GPS satellites with low-cost Rölex watches. These have a maximal inaccuracy of 6 seconds per day. How large is the worst-case measurement inaccuracy of the receiver-satellite distance after one hour?

**Exercise T1.2** *(Orbit Orientation)*
Name the three indicated angles 1, 2 and 3 from the following figure:




**Exercise T1.3** *(GEO)*
Explain the difference between GEO stationary and GEO synchronous orbits.

a) Assuming the inclination is measured relative to the equator.

b) Assuming the inclination is measured relative to the earths orbit around the sun.

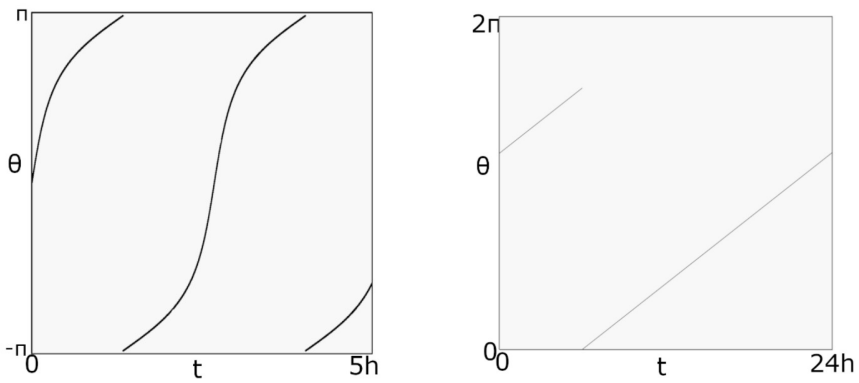



Figure 1: Plots of the true anomaly of a satellite over a period of time

**Exercise T1.4** *(True Anomaly Plot)*
Given the left plot of true anomaly in Figure 1, what can you say about the orbit?

**Exercise T1.5** *(True Anomaly – a different plot)*
Given the right plot of true anomaly in Figure 1, what can you say about the orbit?

**Exercise T1.6** *(Comparing orbits)*
Given the orbits described in the following table:

| Name | semi-major axis | $e$ | $i$ | RAAN | $\Omega$ |
|---|---|---|---|---|---|
| $o_1$ | 10 000 km | 0 | 120 | 0 | 200 |
| $o_2$ | 10 000 km | 0.3 | 20 | 10 | 145 |
| $o_3$ | 20 000 km | 0 | 30 | 50 | 45 |
| $t_1$ | $\infty$ | 1.5 | 0 | 200 | −40 |

Give an order of them in regards to:

a) orbital period

b) mean velocity

c) maximum velocity

d) orbital energy

Hint: You do not have to model them in STK. Think about which orbital parameters are relevant!