To be prepared for the exercises on Dec 18, 2019
(10 points total)

Task 1 (4 points)

The folder on ILIAS contains a Matlab script as well as one RINEX OBS file version 3.04 ($INSA00DEU\_R\_20193391200\_01H\_01S\_MO.rnx$), which provides GNSS observations that were received at the reference antenna on the roof of the institute.

Please use the script *readObs.m* to load this information in Matlab and have a look at the observations in the struct data.

a) Interpretation of the header
   - type of receiver and software version
   - GNSS systems from which observations are included
   - starting epoch in the corresponding time system
   - data rate of the observations
   - main types of observations and their units

b) Plot the total number of received satellites from all systems and the number of received satellites separated by each system

c) Plot the signal-to-noise ratio of GPS satellite with PRN06 and GLONASS satellite with PRN22 as a time series

d) Plot the carrier phase observations of GPS satellite with PRN06 and GLONASS satellite with PRN22 as a time series

e) Plot the 'code-minus-carrier' without ionosphere delay of GPS satellite with PRN06 and GLONASS satellite with PRN22 as a time series by using the formula:

   'code-minus-carrier' without ionosphere delay: $r_{IF} - \varphi_{IF} \cdot \lambda_{IF}$ with

$$\text{carrier phase: } \varphi_{IF} = \frac{f_i^2 \cdot \varphi_i - f_j^2 \cdot \varphi_j}{f_i^2 - f_j^2}; \qquad \text{code phase: } r_{IF} = \frac{f_i^2 \cdot r_i - f_j^2 \cdot r_j}{f_i^2 - f_j^2}$$

$$\lambda_{IF} = \frac{c}{n_i \cdot f_i + n_j \cdot f_j}$$

$$n_i = \frac{f_i^2}{f_i^2 - f_j^2}; \qquad n_j = -\frac{f_j^2}{f_i^2 - f_j^2}$$

Hint: frequency channel of GLONASS (`https://www.glonass-iac.ru/en/CUSGLONASS/`)

Task 2 (2 points)

a) Your GPS signal at L1 is affected by an ionosphere delay that is caused by a TEC value of 132 TECU. How does this translated into pseudorange ionosphere delay at L1 and how much TECU would be necessary to evoke the same delay at the GPS L2 frequency?

b) If your L1 measurements have a noise level of 30 cm and your L2 measurements have a noise level of 25 cm, how large would be the noise level of the ionosphere-free linear combination L3? Compare your results with a combination of L1 (noise level of 25 cm) and L5 (noise level of 20 cm) measurements.

Task 3 (4 points)

The DOP values are measures for the quality of the geometric constellation between satellite and receiver. They depend only on the geometry between the satellites and the receiver. Suppose a receiver is **at the equator in the Greenwich Meridian**, then build up the design matrix A and the Cofactor Matrix Q_{xx}, calculate the 5 DOP values (GDOP, PDOP, HDOP, VDOP, TDOP) and the correlation coefficient between height and Δt for each instance.

a) 4 satellites: elevation 60°, azimuth 0°, 90°, 180°, 270°; 1 satellite in zenith

b) 4 satellites: elevation 45°, azimuth 0°, 90°, 180°, 270°; 1 satellite in zenith

c) 4 satellites: elevation 30°, azimuth 0°, 90°, 180°, 270°; 1 satellite in zenith

d) 4 satellites: elevation 0°, azimuth 0°, 90°, 180°, 270°; 1 satellite in zenith

e) 4 satellites: elevation 0°, azimuth 45°, 135°, 225°, 315°; 1 satellite in zenith