1 Aim

The exercise aims at making you familiar with the easy way of construction of a BODE-diagram which displays the transfer function of a given device as a plot of logarithmic amplitude $A$ and of linear phase shift $\phi$ versus logarithmic frequency $f$ (or period $1/f$). Its advantage is that response curves are approximated by straight lines (see IS 5.2). The main features are:

- any Pole in the transfer function generates an amplitude decay proportional to frequency $f$ (20 dB per decade or 6 dB per octave) and a phase shift $\phi$ of $-90^\circ$;
- any Zero causes a slope of 1:1 too and a phase shift of $+90^\circ$;
- corner frequencies (e.g., of filters) correspond to the point of intersection of two straight lines.

All stages of a signal-transfer chain can thus be constructed component-wise, one after the other. It is recommended to decompose all functions into parts of 1$^{st}$ or 2$^{nd}$ order. One gets the complete transfer function by multiplying these individual functions. In both the logarithmic amplitude scale and the linear phase scale this means adding the related individual curves.

2 Tasks

Task 1: Plot the BODE-diagrams (amplitude only) of the following seismograph components:

- **Seismometer**
  - Transducer Constant
  - Natural Period $T_S = 5\ s$
  - Attenuation $D_S = 0.707$
- **HIGH Pass HP1** (1$^{st}$ order)
  - Magnification $A_{H1} = 3$
  - Corner Frequency $f_{H1} = 0.01\ Hz$
- **LOW Pass LP1** (1$^{st}$ order)
  - Magnification $A_{L1} = 5$
  - Corner Frequency $f_{L1} = 0.2\ Hz$
- **LOW Pass LP2** (2$^{nd}$ order)
  - Magnification $A_{L2} = 2$
  - Corner Frequency $f_{L2} = 10\ Hz$
  - Attenuation $D_{L2} = 0.707$

Task 2: Plot the overall amplitude response of the system approximated by straight lines on double logarithmic paper (see Figure 1).
Figure 1
3 Solution

The solution to this exercise is given in Figure 2 below.

*Figure 2* Overall BODE-diagram (solid curve) for the seismograph amplitude response. It results from the logarithmic addition of the BODE-diagrams of all individual components given in Task 1.