Title	Plotting seismograph response (BODE-diagram)
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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 ϕ 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 ϕ of -90°;
- any Zero causes a slope of 1:1 too and a phase shift of +90°;
- 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 1st or 2nd 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	G_S	=	15.915 Vs/m
Natural Period	T_S	=	5 s
Attenuation	D_S	=	0.707
HIGH Pass HP1 (1st order)			
Magnification	A_{H1}	=	3
Corner Frequency	f_{H1}	=	0.01 Hz
LOW Pass LP1 (1st order)			
Magnification	A_{L1}	=	5
Corner Frequency	f_{L1}	=	0.2 Hz
LOW Pass LP2 (2nd 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).

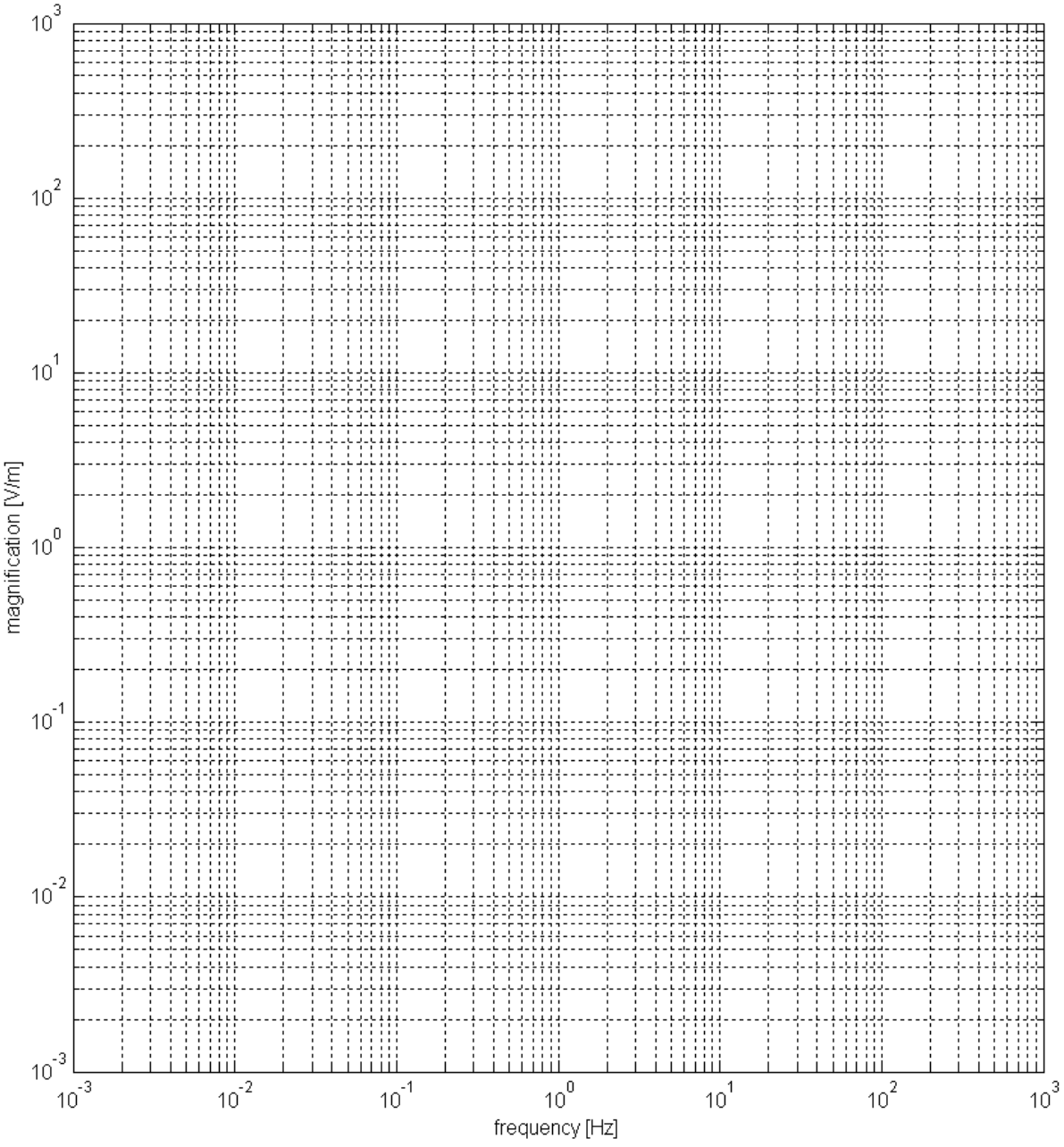
magnification [V/m]
frequency [Hz]
10^3
10^2
10^1
10^0
10^-1
10^-2
10^-3
10^-3
10^-2
10^-1
10^0
10^1
10^2
10^3

Figure 1

3 Solution

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

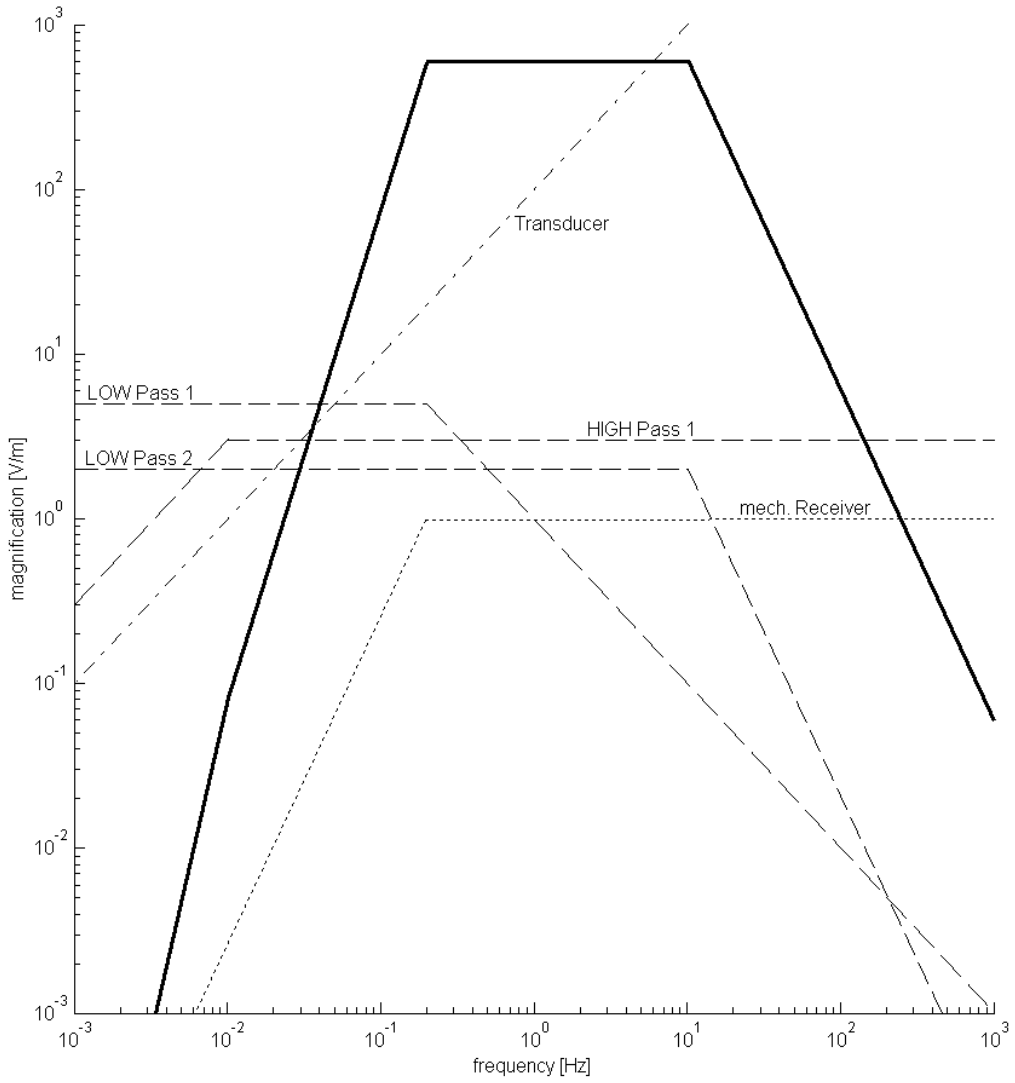

Figure 2 Overall BODE-diagram (solid curve) for the seismograph amplitude response. It results from the logarithmic addition of the BODE-diagrams of all individual components given in Task 1.