I.
A guitar string is plucked, and the fundamental frequency of the resulting sound is 100 Hz. The length of the string is 65 cm. A 40 ms second excerpt of the signal is taken.
a) Draw the time-domain signal of the excerpt. (2p.)
b) Draw the spectrum of the excerpt. (2p.)
c) Mention a sound synthesis method that could be used to synthesize the above signal, and explain how its parameter has to be chosen in order to produce the above explained sound. (2p.)


II.
Explain two methods that can be used in AD-conversion to reduce the audibility of the quantization noise. Explain how the methods work, and why the audibility of the quantization noise is reduced. (6p.)

III.
Below figure represents a two-band filter bank. Blocks LP and HP are a lowpass and a highpass filter, respectively. The cutoff frequency of both filters is $f_s / 6$, when f_s is the sampling frequency. $\downarrow 2$ denotes decimation by factor two, and $\uparrow 2$ denotes interpolation by factor two.
a) Is this a uniform frequency resolution filter bank? State reasons. (1,5p.)
b) Is this a critical sampling filter bank? State reasons. (1,5p.)
c) Using the filter bank, a shelving filter is implemented, which boosts high frequencies ($f > f_s / 6$) by 10 dB. What processing is needed in the blocks SP_1 ja SP_2? (3p.)
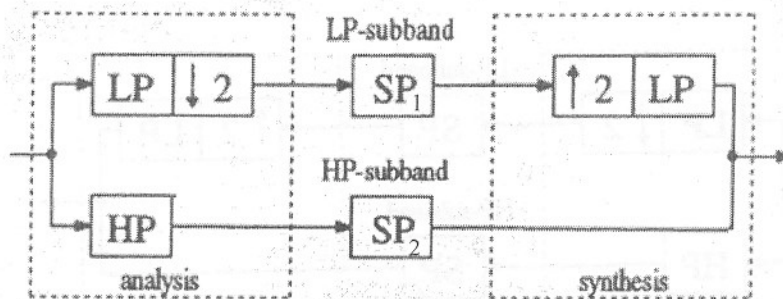
IV.
a) What is meant by dynamic range control? Where it is needed? How a limiter processes a signal? (4p.)
b) What is the difference between intensity stereo coding and M/S stereo coding?

V.
Explain shortly the basic idea of perceptual audio coding. What is the main task of a perceptual model in the encoder? How perceptual coding differs from source coding?