



You have max three (3) hours for answering the questions. You may leave after the first hour but not before. Allowed/Required accessories: pens, calculator (no books, notes, laptop computers/PDAs or conversation). Papers will be provided by the EE department. Turn off your mobile phone. The results can be expected to appear one month after examination on the course web pages.

- You can answer either in English or Finnish. Voit vastata myös suomeksi.
- **Answer only five (5) questions.** If you answer more, only the worst five will be taken into account.
- Illustrate your answers by using graphics, formulas, tables etc. whenever possible.
- Everyone has to leave a paper, even if it contained only your name and student number!

Good luck with the examination!

1. Explain briefly but exactly:
 - (a) HRTF
 - (b) convergence factor μ (mu)
 - (c) AAC
 - (d) sinc function
 - (e) RIR
 - (f) minimum phase
2.
 - (a) Explain chorus, flanging and phasing. What are their similarities and differences?
 - (b) Explain dither: what is it, what are the main methods, why and how it is used?
3. Frequency warping. Explain briefly the psychoacoustic background of warping, draw and explain the DSP realization. Give at least two example use cases of filter design applications using warping.
4. Sample rate conversion
 - (a) Approximate the following sample rate conversions by at least two rational factors each and calculate their error percentages.
48KHz \rightarrow 44,1KHz
44,1KHz \rightarrow 32KHz
13KHz \rightarrow 12,5KHz
 - (b) Explain how fractional delay filters can be used in sample rate conversion.
5. Your choice
 - (a) Design an exercise on one of the course topics. The exercise should be a calculation or analysis, not an essay or terminology task.
 - (b) Solve your exercise!
6. The guitar player Nigel Tufnel from the band Spinal Tap, has an analog amplifier with the following controls. Implement the controls digitally. Explain your solution, including the parameters and draw a block diagram of the system.

