Multirate Signal Processing

Seminar 1

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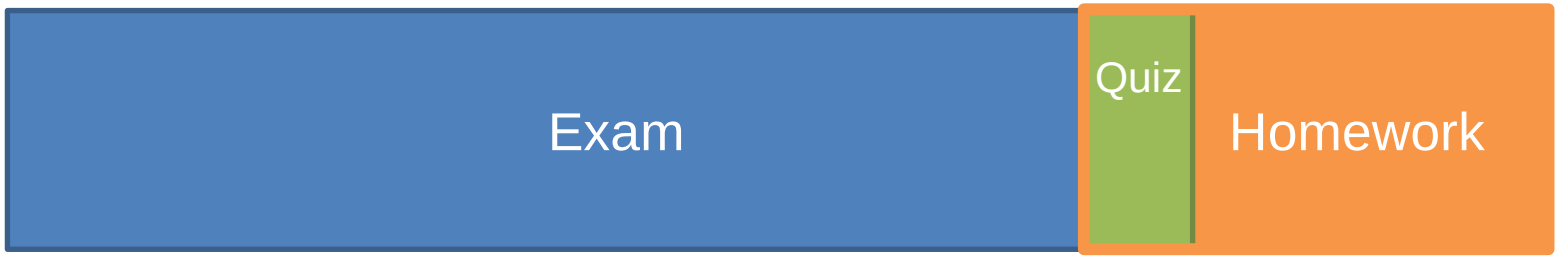
Office hour: Tuesday 10^{00} – 11^{00} and 13^{00} – 14^{00}

1. General Information



Exam

- 70% of the grade
- Needs to be passed in order to pass the course
- 90 minutes

Seminar points

- 30% of the grade, of which:
  - 25% quizzes
  - 75% homeworks

Gained points will only be added after passing the exam. **When a student fails the exam the points stay valid until the lecture is held again and there are new homework assignments (in the following summer semester)**

1. General Information

Quiz

- Every week after the lecture
- Test related to the latest content of the lecture
- Sign in at moodle2 (https://moodle2.tu-ilmenau.de/)
- Use your university login and password
- Fakultät EI --> Institut für Medientechnik --> FG Angewandte Mediensysteme --> Multirate Signal Processing

1. General Information (1/2)

a) Homework assignments:

- Solve with Python
- Can be done in groups of max 3 people
- Show and explain your solution on seminars
- You can show a homework **only** during the seminar
- Bring your laptop if it is possible, otherwise an USB stick
- Submission via email is not possible

b) Each group member:

- should have working code (use of clouds)
- has to know the code

c) Everyone has to be able to answer theory questions

1. General Information (2/2)

Homework assignments:

- Deadline for homework submissions – the last lecture week
- Do not use build-in functions
- Use functions in the code
- Main function has to be clearly understandable without redundant (often used in each homework) actions

1. General Information

Homework submission:

Has to be done in form of presentation

1) Run your code to show the results
2) Explain all the figures
3) Show file sizes (if needed)
4) Answer questions regarding your code
5) Answer theory questions
6) Done, you can go home or wait for your next turn to submit one more HW
7) **Do not talk loud, respect your friends and colleges and let them submit their HWs in silence**
8) **If code is not working – try to figure out why (at home) and explain me**

2. Homework assignment 1

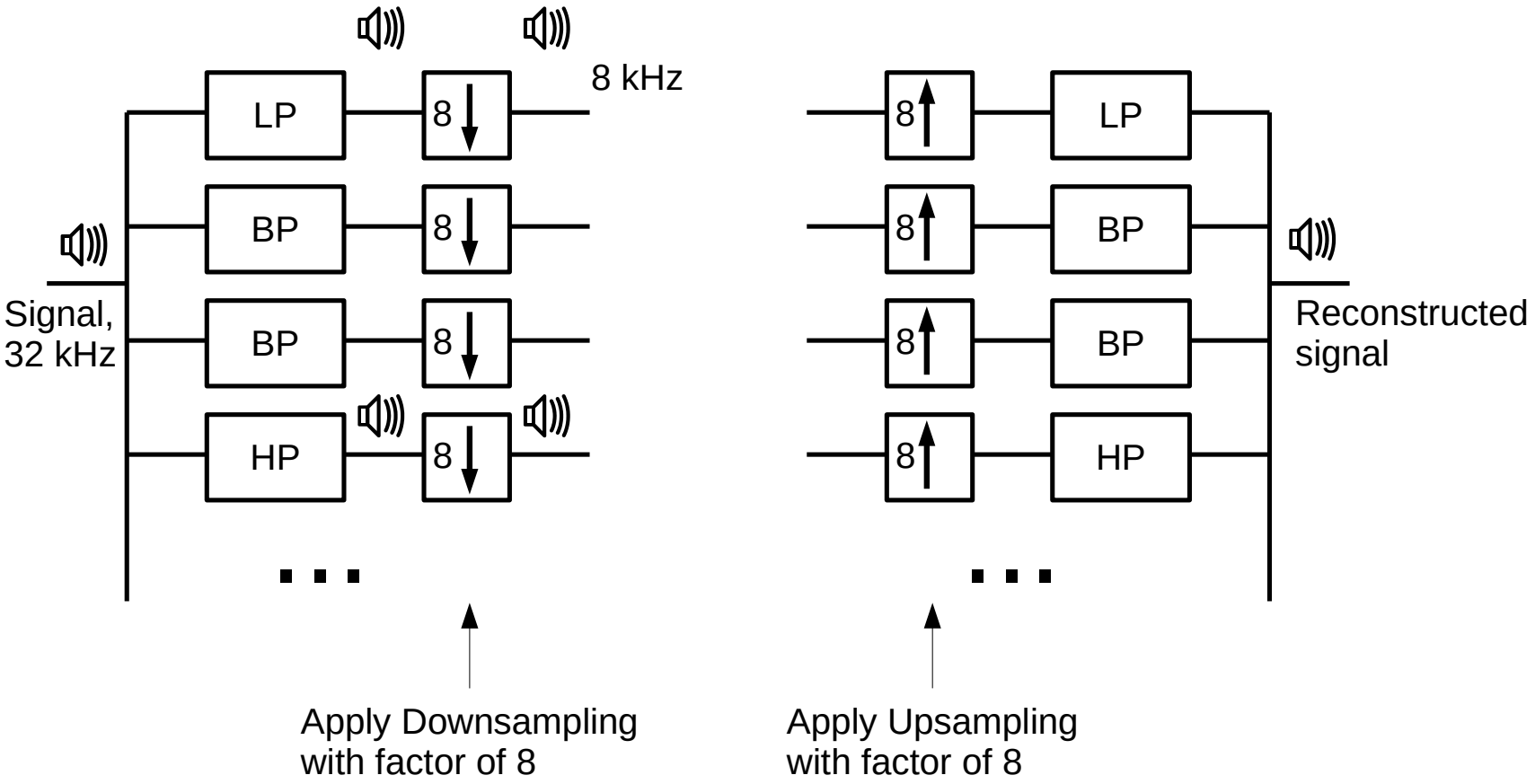
Task:

- Download audio file `"Track32.wav"` from Moodle.
  - Use only 1-st channel (in Python – channel index №=0)
- Use 8-band filter bank to decompose an audio signal into subbands. Reconstruct the audio signal using the synthesis filter bank.

2. Homework assignment

1. Implement a 8-band decomposition
   - use a 8-band filter bank with simplest FIR filters for analysis and synthesis (use remez function from scipy.signal library)
   - Take an audio, and apply this 8-band decomposition to the audio. In this way you get 8 new audio signals.
   - Listen to audio signals (**1-st and 4-th subbands**) before and after applying Downsampling at the corresponding sampling rates. What do you notice?
   - The corresponding signal flow graph is shown in the next slide.
2. Plot the Impulse and Frequency responses of your filters in one window on top of each other (**Magnitude in dB, freq. Normalized**).
3. **The bandwidth of all filters has to be the same.**

2. Homework assignment



2. Homework assignment

3. Reconstruct the audio signal
    - Use the synthesis filter bank
    - Listen to the reconstructed audio signal and evaluate it

Hints:
    - ADSP lecture 7 – filter types
    - ADSP lecture 8 – filter design with *‘remez’*

Link 1: External web page

Link 2: Moodle ADSP course

2. Homework assignment

Example: Low pass filter for 1/4 of the lowest frequencies:

```
import scipy.signal as sig
import matplotlib.pyplot as plt
import numpy as np


#Nyquist frequency is normalized to 0.5!:
h=sig.remez(16,[0,0.125,0.15 ,0.5],[1,0],[1,100])
#Impulse response:
plt.plot(h)
plt.show()

#Frequency response:
w,H=sig.freqz(h)
#Plot magnitude in dB:
plt.plot(w,20*np.log10(np.abs(H)))

plt.show()
```