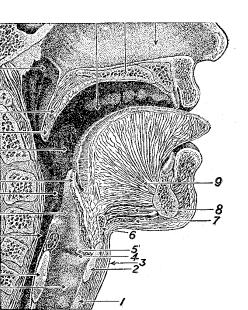


Infocommunication Sound, hearing and speech



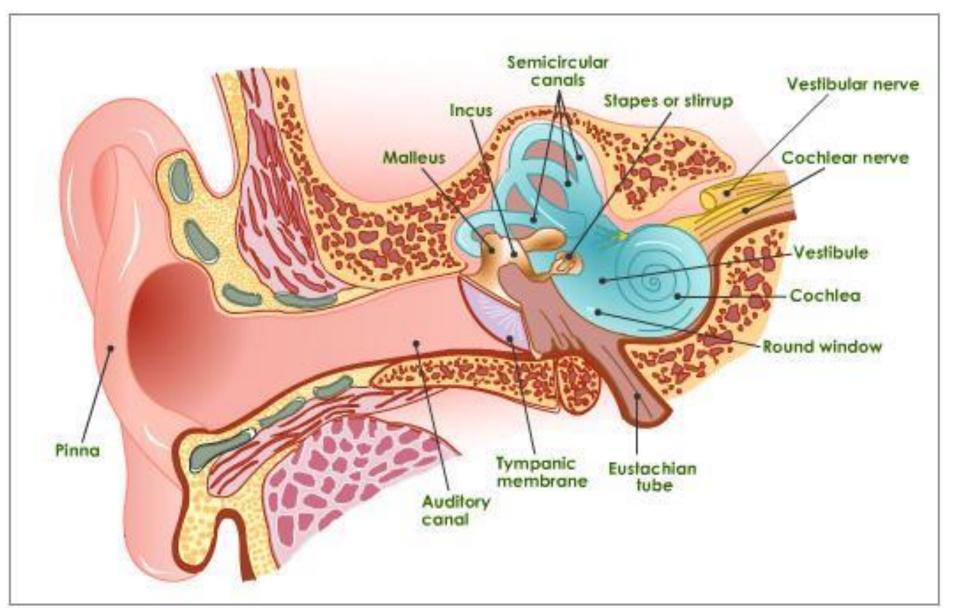
Tamás Csapó csapot@tmit.bme.hu> 2018 Spring



Topics

- Basic signal processing
- Sampling and quantization
- Analog modulation
- Sound, hearing and speech
- Digital baseband modulation
- Digital carrier modulation
- Error Detection Coding
- Error Correction Coding
- Radio, guided waves
- Light and vision
- Radio Communication
- Video Broadcasting
- GSM, Mobile communication

Structure of the human ear



Békésy György / Georg von Békésy

Nobel prize in 1961 (function of the cochlea)



Sound pressure level

Sound Pressure Level Sound Pressure n 140 dB Threshold of Pain Jet Engine 100000000 130 120 (100 m distance) 0000000 -110 neumatic Chipper 100 000000 Heavy Truck 80 100000-70 Conversational 60 10000-50 40) 1000 30 100 20____0 Threshold of Hearing

Source: http://personal.cityu.edu.hk/ ~bsapplec/sound.htm

Sound pressure level

- 440 Hz tone (A4 on musical scale)
 - reduced in 1 dB steps

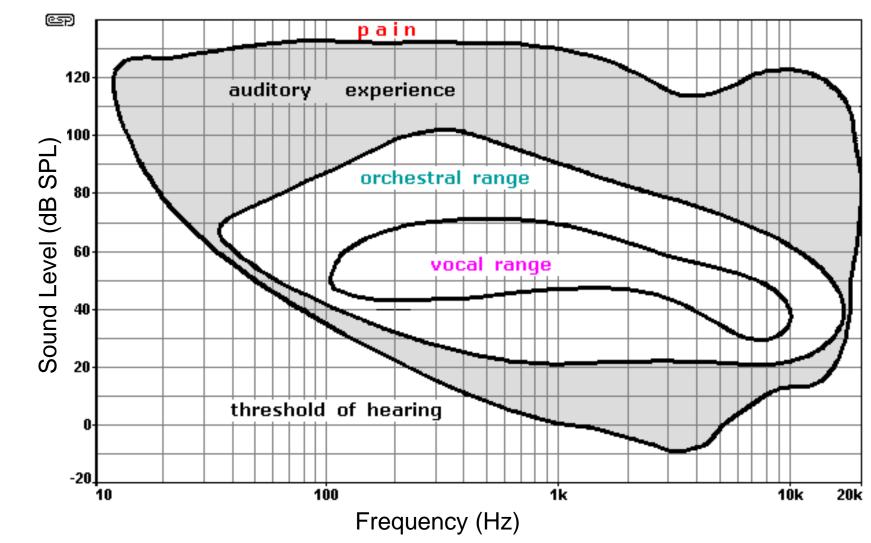


- reduced in 3 dB steps
- reduced in 5 dB steps

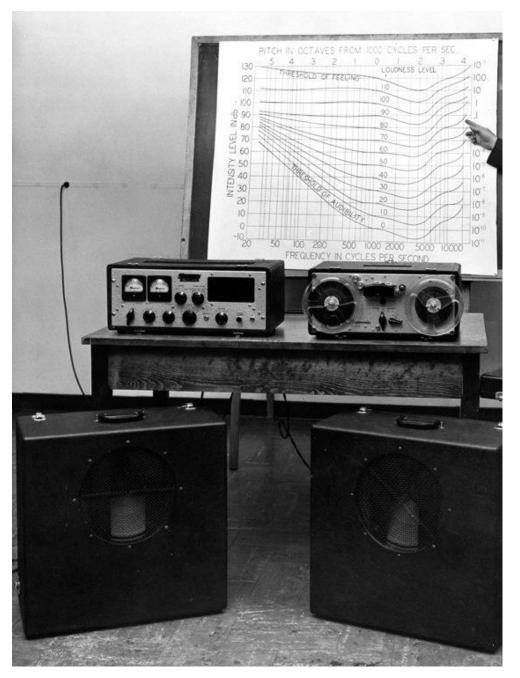




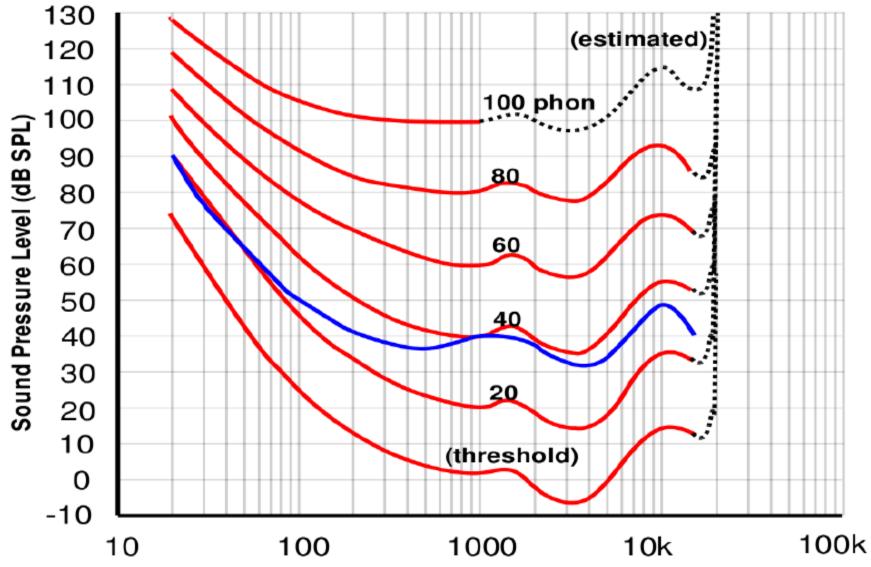
Limits of human hearing



Fletcher & Munson 1933 experiment



Equal loudness contours



Equal-loudness contours (red) (from ISO 226:2003 revision)

Original ISO standard shown (blue) for 40-phons