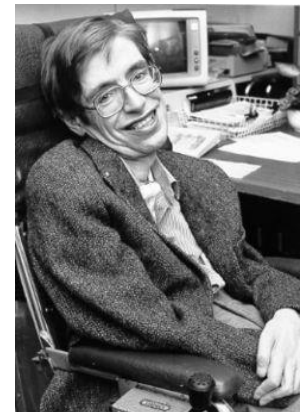


Welcome to
Audio Signal Processing
(AME/ECE 272/472, TEE 472)

Zhiyao Duan

What is Audio Signal Processing?

- Intentional manipulation of sound (e.g., music and speech)
- To **analyze** sound
 - Speaker recognition, music transcription
- To **modify** sound
 - Distortion, chorus, 3D audio, vocal removal
- To **make** new sound
 - Keyboard, speech synthesis, singing synthesis



"Penny Lane"
(2001 © MSR)



Hanamizuki
2017 © UPF

Why should we care?

- It's everywhere!
- It's fun!
 - Let's look at some demos
 - Advanced Voice Transformation
<https://www.youtube.com/watch?v=wnZq5KaYpQ>
 - Interactive Music Editor

Course Topics

- Fundamentals
 - Quantization, sampling, digital filters, Fourier transforms, spectrum, cepstrum
- Analysis
 - Timbre modeling, classification, pitch tracking, beat tracking
- Synthesis
 - Speech modification, pitch shifting, physical modeling
- Effects
 - Equalization, reverberation, 3-D audio, dynamic range control, etc.

Course Objectives

- Good understanding of various topics of audio signal processing
- Build intimate connections between theory and practice
- Improve implementation skills
- Gain experience in doing small-scale research projects
- Enhance capabilities of problem solving, team-working, presentation, etc.

Course Objectives In Concrete Terms

- You will know after the course
 - Why CD quality sound uses 16-bit quantization
 - How to digitize an analog signal
 - What is the time-frequency resolution tradeoff
 - How to shift pitch without changing speed
 - What is timbre
 - How to change your voice to Donald Duck's
 - How to plot the pitch contour of a solo trumpet
 - How to track beats of music
 - How to design an equalizer
 - How to simulate reverb
 - How to localize sound sources
- You will accomplish a cool project with teammates!

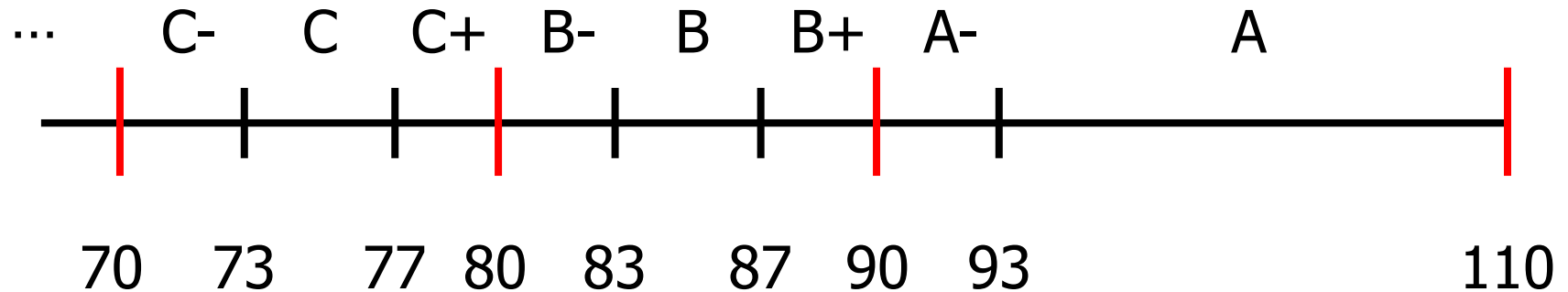
Course Information

- Course website: all materials
 - <http://www.ece.rochester.edu/~zduan/teaching/ece472/index.html>
- Piazza: Q&A + discussions
 - <https://piazza.com/class/k5ftm6q2p5cd5>
- Blackboard: announcement + assignment submission
 - <https://learn.rochester.edu/>
- Office hour: 4-5 PM on Wednesdays in CSB 720

Assignments

- Total (110 points)
 - Homework (80 points)
 - 1st – 5th: Matlab
 - 6th – 8th: DSP board
 - Final project (30 points)
 - Proposal (5 points)
 - Project update (5 points)
 - Presentation/demo (10 points)
 - Final report (10 points)

Grading



- No extra credit
- No curve
- Students enrolled in 272 will get 10 points boost

Important Policies

- Late homework: 20% deduction / day
- Do your own work
- Attendance is highly encouraged
- Do your best not to be late

Prerequisites

- Signals and Systems
 - ECE 241 or equivalent
- Basic programming
 - ECE 114 or equivalent (C/C++) and Matlab programming
- Preferred but not required
 - Digital Signal Processing (e.g., ECE 246)
 - Random Processes (e.g., ECE 440)

Required Textbooks

- **DASP** - Udo Zölzer. (2008). *Digital Audio Signal Processing*. 2nd Edition. Wiley. **Free online copy** through UR library.
- **DAFX** - Udo Zölzer (Eds.). (2011). *DAFX: Digital Audio Effects*. 2nd Edition. Wiley. **Free online copy** through UR library.
- **SASP** - Julius Smith. (2010). *Spectral Audio Signal Processing*. **Free online book.**

References

- Theodoros Giannakopoulos, and Aggelos Pikrakis. (2014). *Introduction to Audio Analysis: A MATLAB Approach*. Academic Press. **Free online copy** through UR library.
- Donald Reay. (2012). *Digital Signal Processing and Applications with the OMAP-L138 eXperimenter*. John Wiley & Sons. **Free online copy** through UR library.
- Research papers

Tips for Studying This Course

- This is a challenging course!
- Try to come to lectures
 - Helps you grasp the main ideas quickly
- Devote enough time after class
 - Reading + implementation
 - Expect 10+ hours home study time each week
- Start doing homework early
 - Discuss with others, TAs, and me
 - Discuss on Piazza
 - Submit homework on time!

Ready? Let's Go!

