

SI 100B 音频处理应用

chenlei2@shanghaitech.edu.cn

2020/10/30

Outline

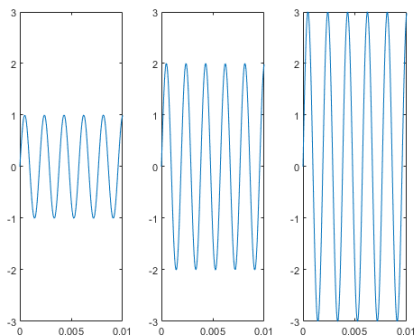
- Sound and signal
- Frequency domain and Fourier transform
- wave filter
- Homework

Recognize sound

- Sound is a wave produced by the vibration of an object

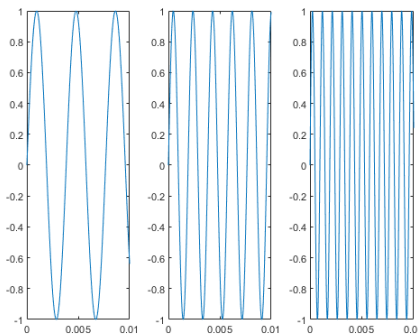
$$A \sin 2\pi f t$$

volume :



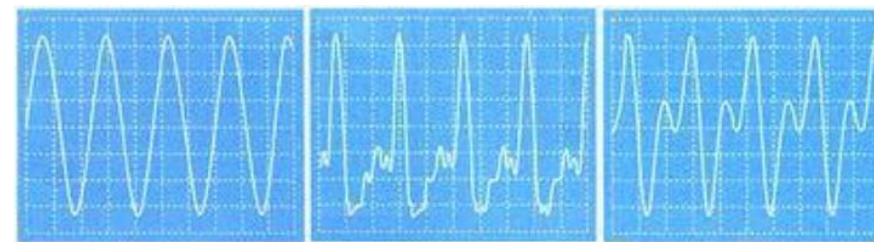
$$A \sin 2\pi f t$$

tone:



$$A \sin 2\pi f t$$

timbre :



甲 音叉

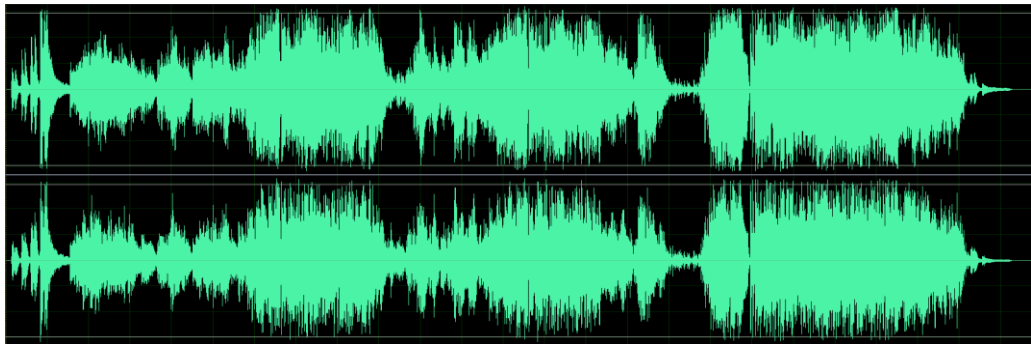
乙 钢琴

<https://www.bilibili.com/video/dikeyuan>

$$A(t) \sin 2\pi f t$$

the form of sound

my world



computer

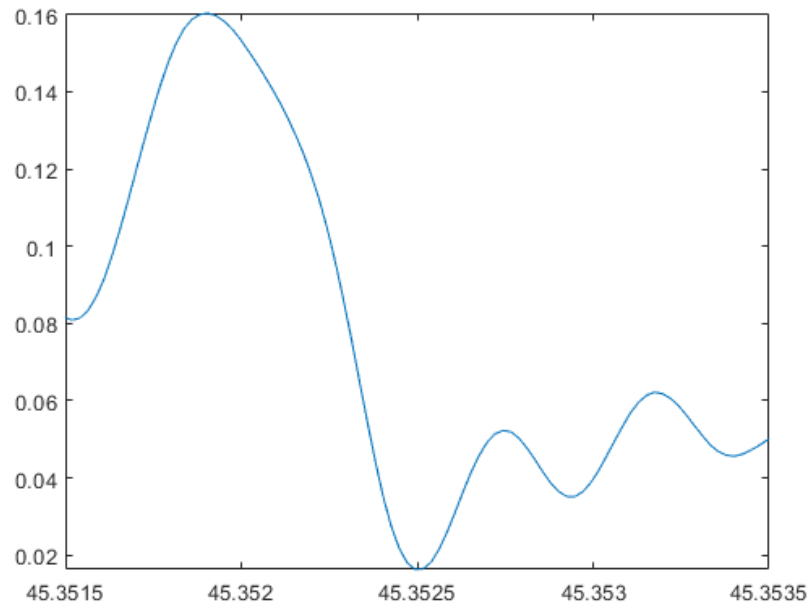
命令行窗口

```
>> clear;clf;  
[y,Fs] = audioread('magnet.mp3');  
fx >> |
```

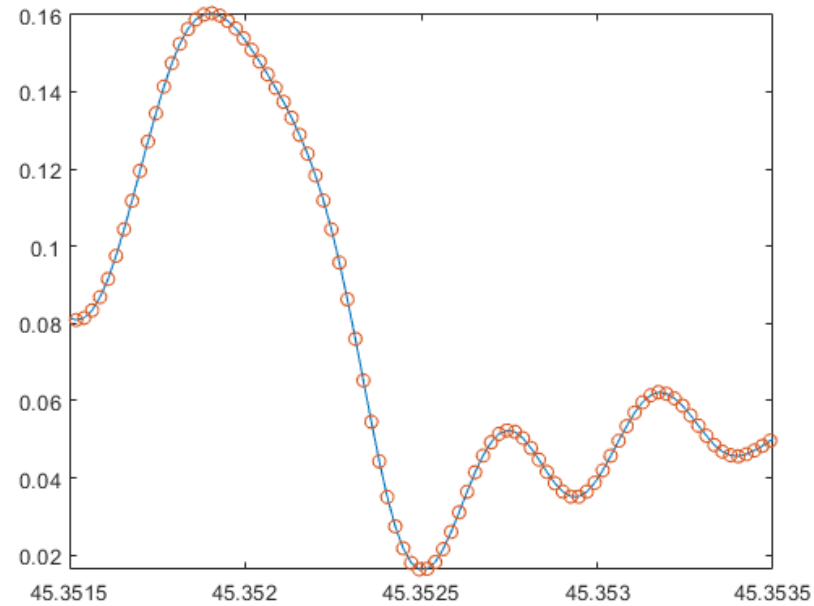
工作区

名称 ▲	值	大小	类
Fs	44100	1x1	double
y	10907760x2 double	10907760x2	double

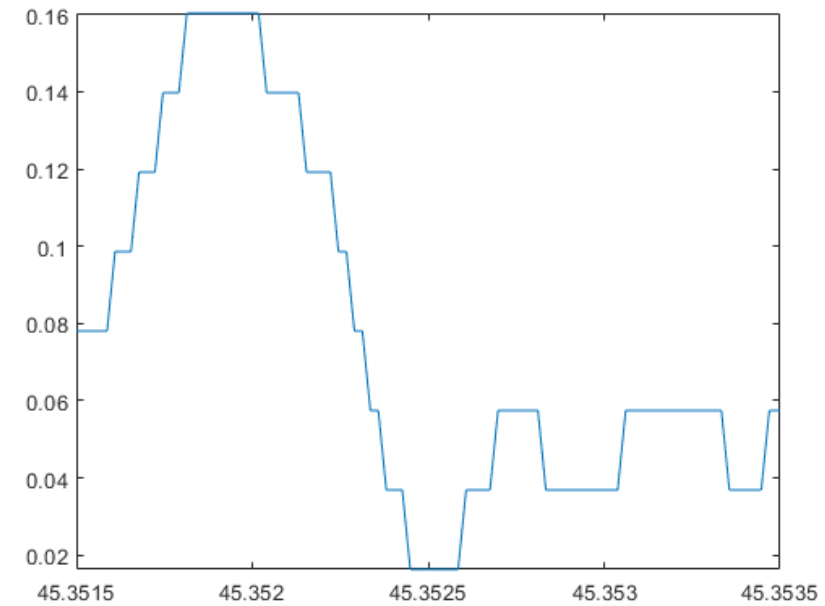
What happened



original signal



sampling



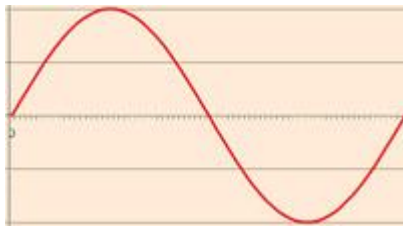
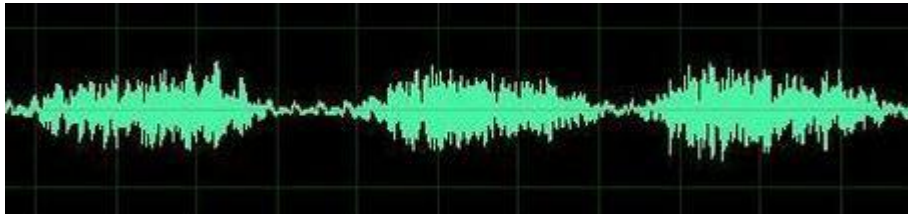
quantification

Outline

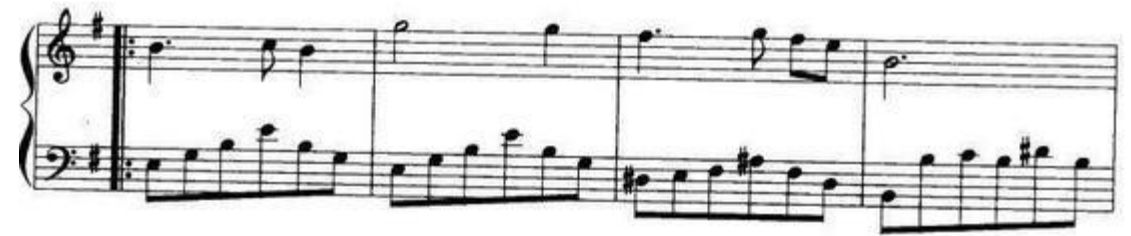
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What is frequency domain

time domain :



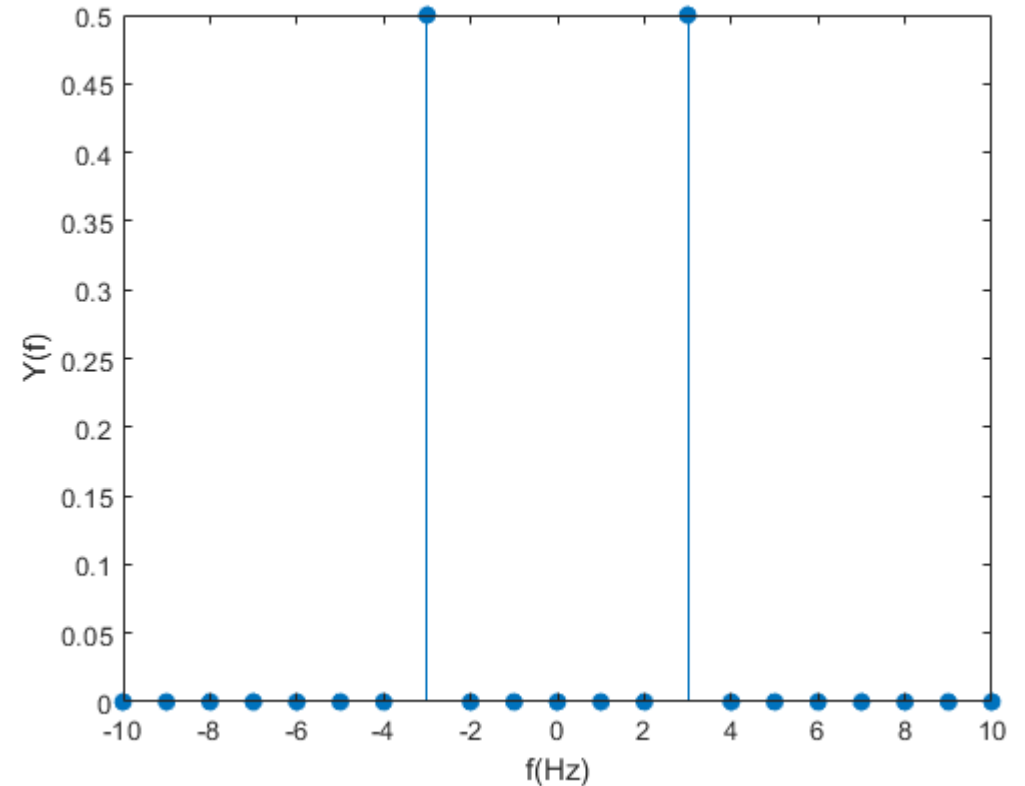
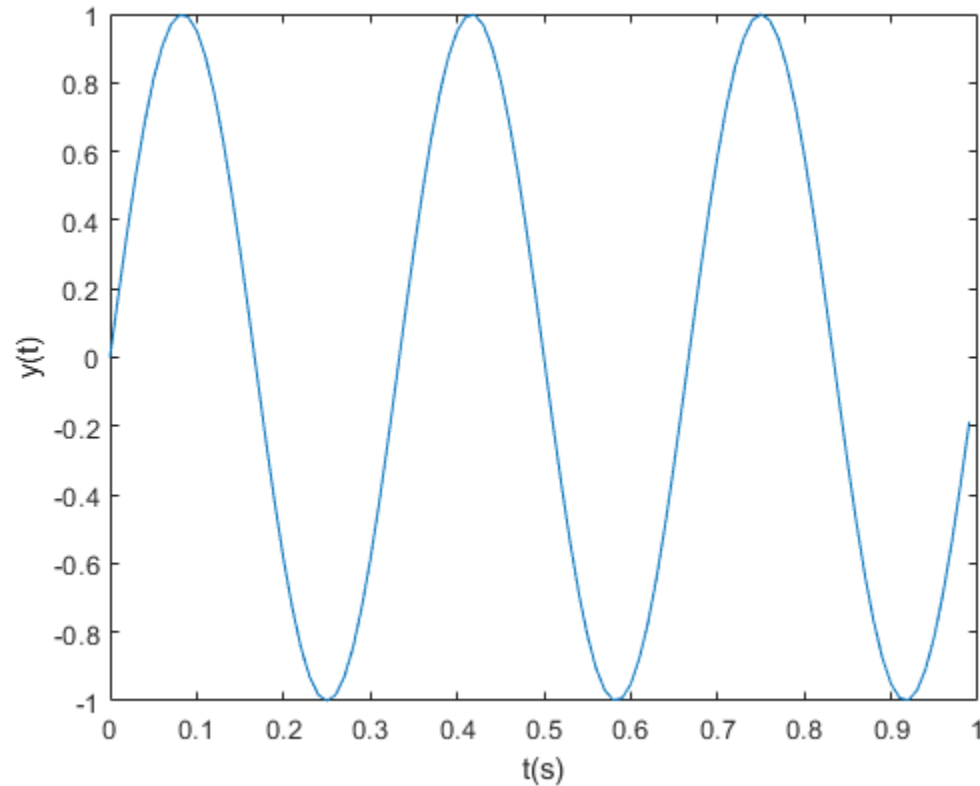
frequency domain :



How to see the frequency domain

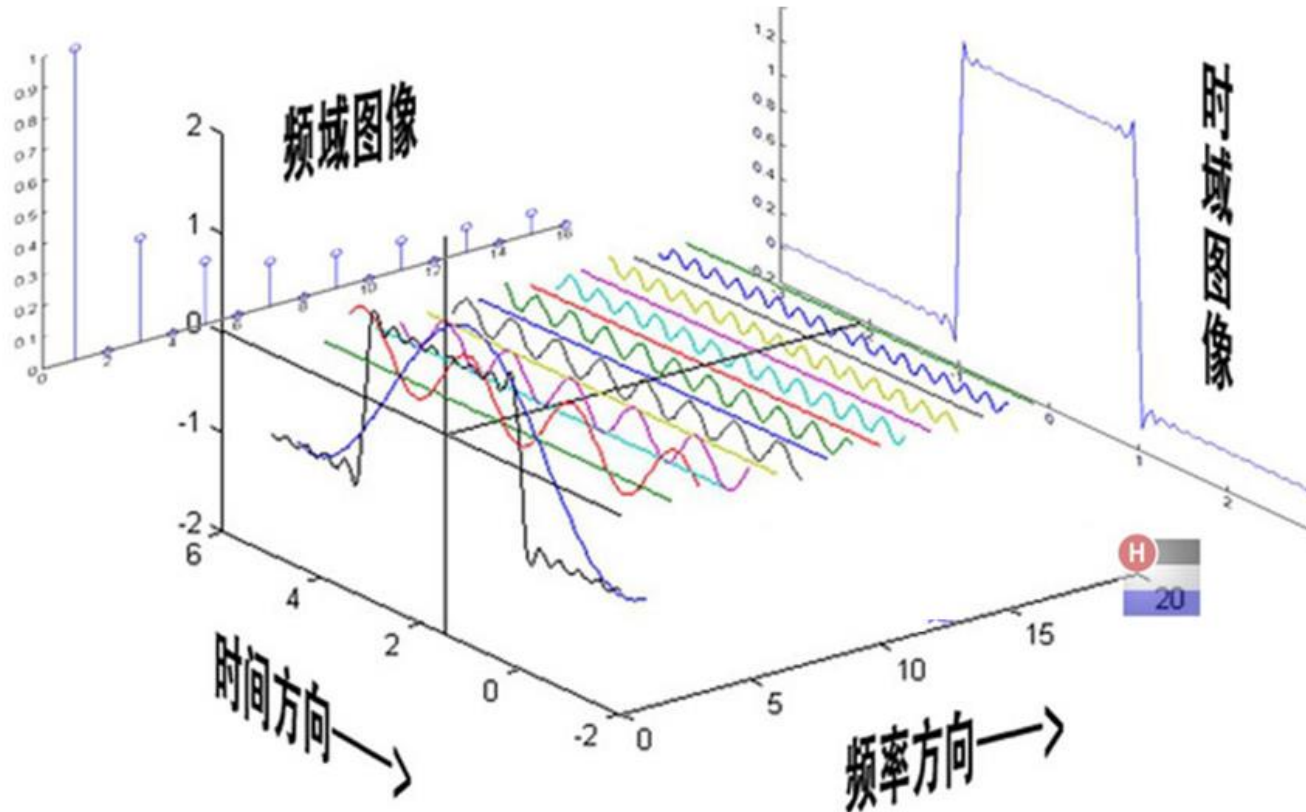
- What is frequency domain?

$$A \sin 2\pi f t$$

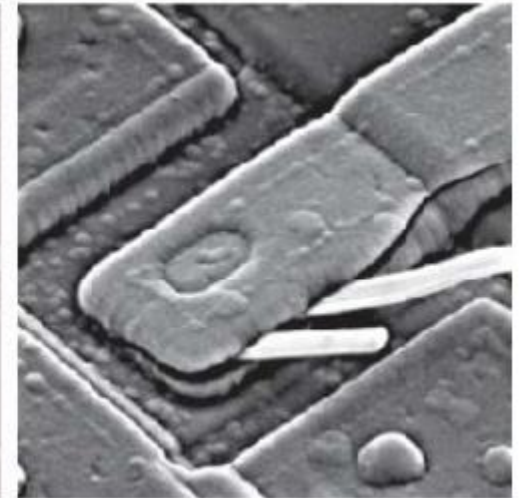
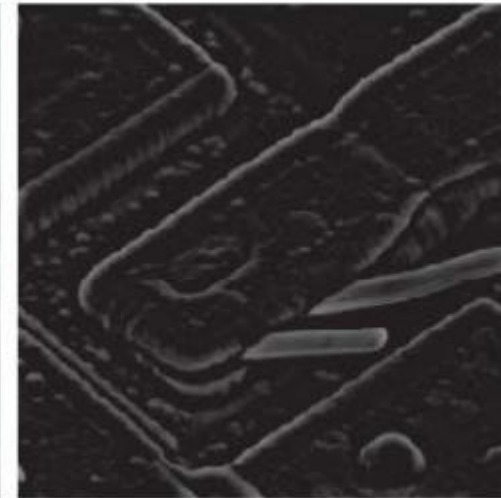
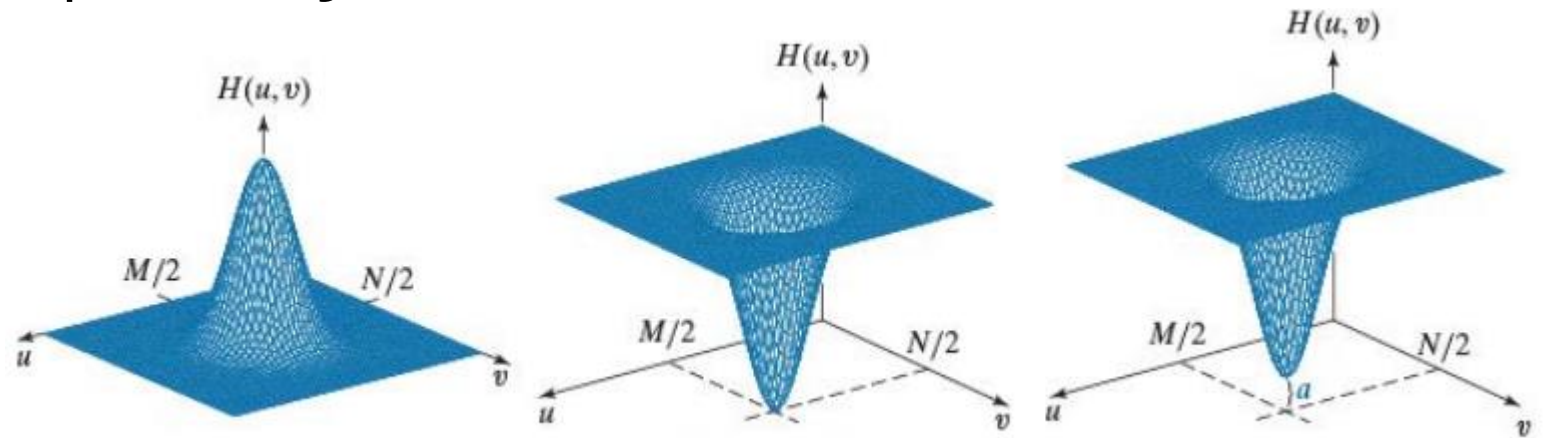
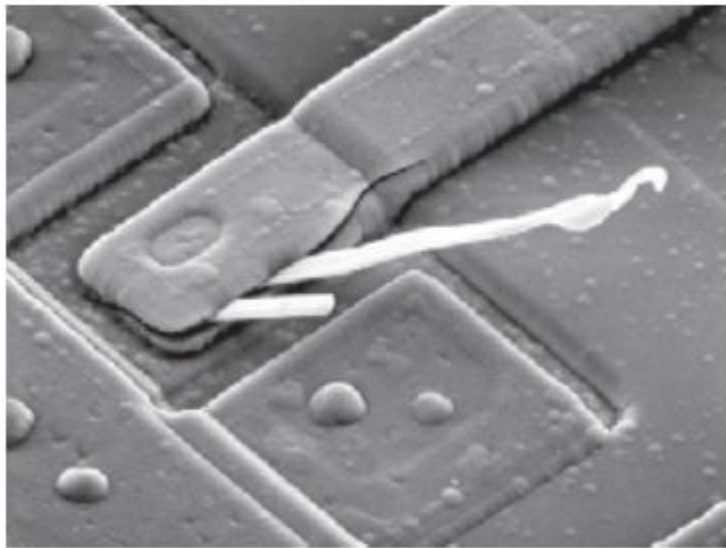


Time domain frequency domain correspondence

- What is frequency domain ? $A \sin 2\pi f t$
- Any wave can be regarded as the superposition of sine waves with different amplitudes, phases and frequencies



application of frequency domain



application of frequency domain



application of frequency domain



Fourier Transform Function

- dt and Fs
- Calculation of time axis and frequency axis
- fft
- fftshift
- abs

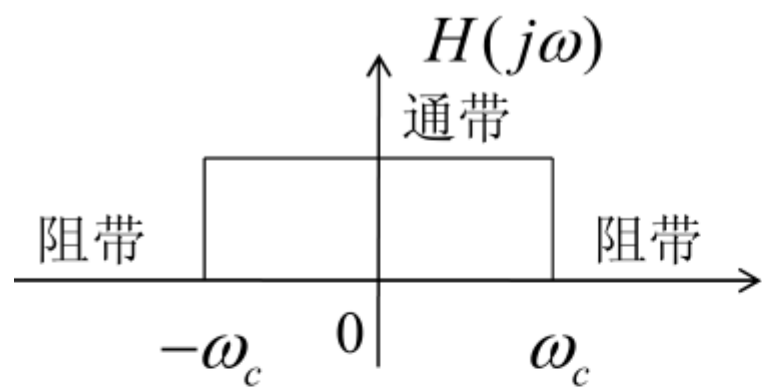
$$F(\omega) = \mathcal{F}[f(t)] = \int_{-\infty}^{\infty} f(t)e^{-i\omega t} dt$$

```
clear;clf;
dt = 0.01; Fs = 1/dt;
t = 0:dt:1-dt;
y = sin(2*pi*3*t);
N = length(y);
df=Fs/N;
f = (-N/2:N/2-1)*df;
Y = fftshift(fft(y))/N;
plot(t,y); xlabel('t(s)');ylabel('y(t)')
figure;
stem(f,abs(Y),'filled');axis([-10 10 0 inf]);
xlabel('f(Hz)');ylabel('Y(f)')
```

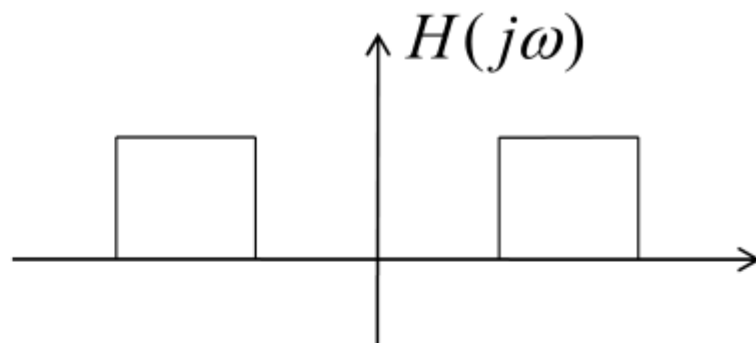
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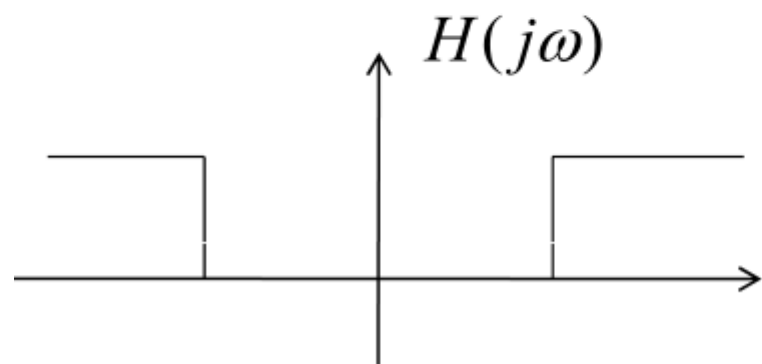
Types of filters



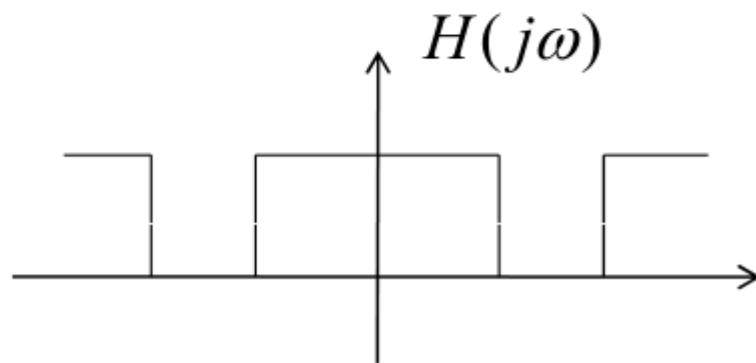
理想低通



理想带通

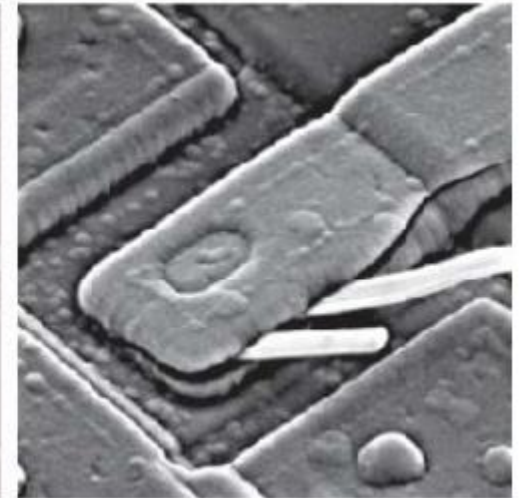
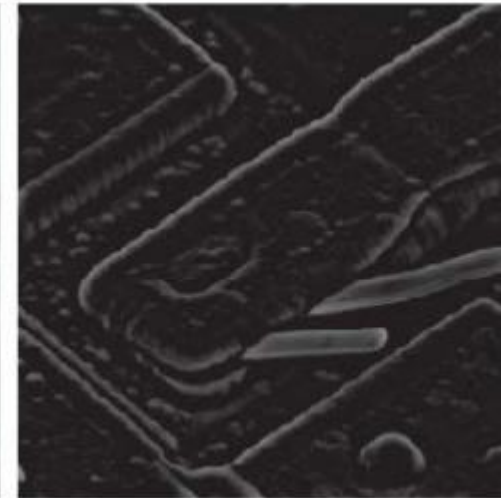
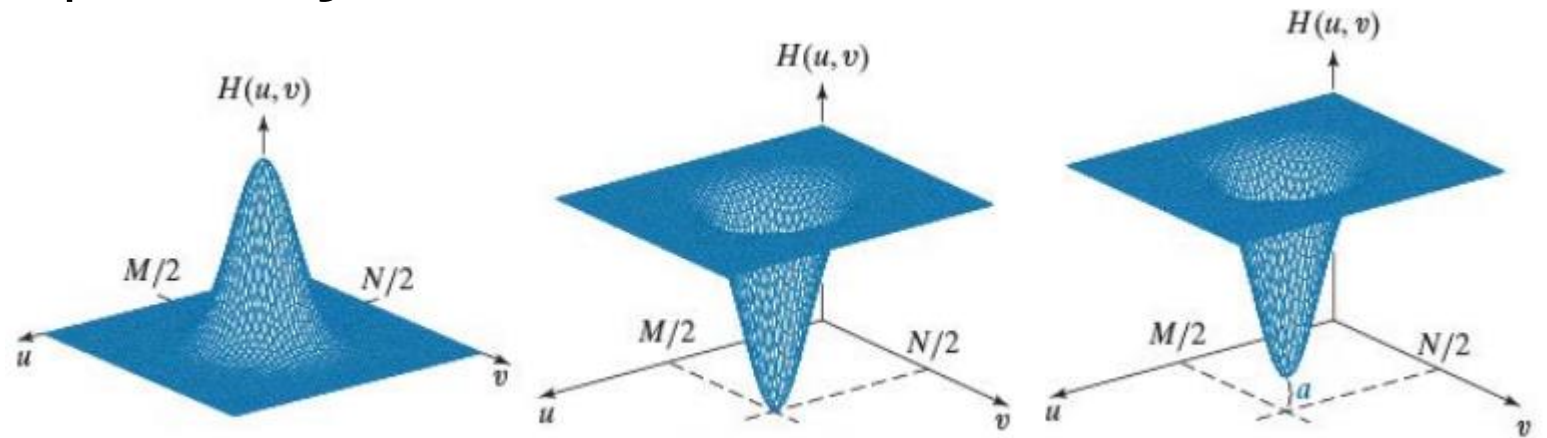
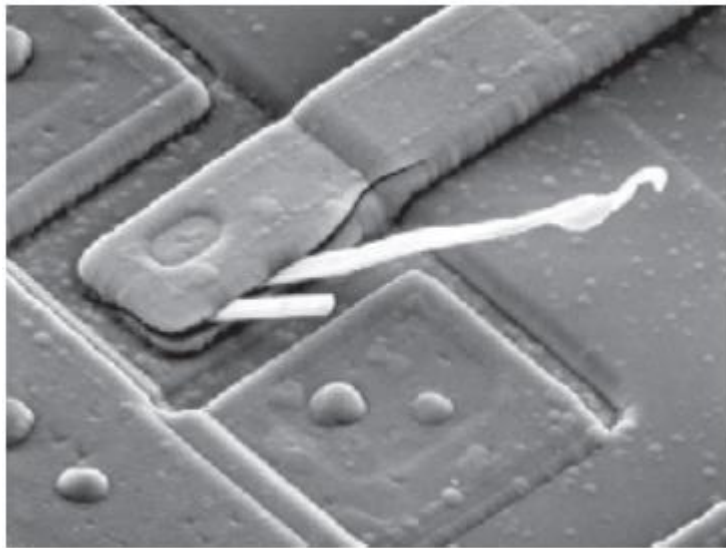


理想高通



理想带阻

application of frequency domain



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Homework

2、读入音频文件magnet.mp3，取的第1分钟至2分钟双声道数据，按照用户要求对其进行滤波处理。

a. 使用二6阶巴特沃斯滤波器实现低通，带通，高通滤波器功能；

低通滤波器截止频率为500Hz

高通滤波器截止频率为800Hz

带通滤波器上下截止频率为800Hz， 500Hz

b. 为用户提供低通、带通、高通等不同类型的滤波器的选择；

c. 按照用户的选择对magnet.MP3进行滤波，画出对应频谱图，并播放滤波之后的音频；

滤波器相关函数

- butter

`[B,A] = butter(N,Wn,'high')` --- 用来设计高通滤波器

`[B,A] = butter(N,Wn,'low')` designs a lowpass filter.-- 低通滤波器

`[B,A] = butter(N,Wn)`-- 带通滤波器

- filter

`y = filter(b,a,X)`

Homework

3、声音采集及播放

- a. 使用PC自带的声卡采集外部音源（自言自语，放声歌唱都可以），同时播放。
采集时间持续30秒；采样率设置为44.1kHz；
- b. 30秒采集时间结束后，将这30秒的数据作为一个整体，进行傅里叶变换，画出时域图及频域图。

音频处理相关函数（2）

- audioDeviceReader
- getAudioDevices
- audioDeviceWriter
- release
- 其它
 - pause
 - tic, toc

音频处理相关函数 (2)

- audioDeviceReader

audioDeviceReader('Device',device{1},'SamplePerFrame',samplePerFrame,'SampleRate',fs)

- getAudioDevices

getAudioDevices(audioDeviceReader/audioDeviceWriter)

- audioDeviceWriter

audioDeviceWriter('SampleRate',fs,'Device',device{1})

- release

release(c)

- pause

pause (延迟秒数)

- tic, toc

tic
operations
toc

