computer assignment 3

IBME

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part1:

references:

https://www.ninds.nih.gov/health-information/patient-caregiver-education/brain-basics-understanding-sleep

https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/brain-waves

https://www.sleepfoundation.org/stages-of-sleep

https://courses.lumenlearning.com/wsu-sandbox/chapter/stages-of-sleep/

https://www.verywellmind.com/what-are-delta-waves-2795104

https://www.nature.com/articles/s41598-017-15966-6

The first stage of NREM sleep is known as stage 1 sleep. Stage 1 sleep is a transitional phase that occurs between wakefulness and sleep, the period during which we drift off to sleep. During this time, there is a slowdown in both the rates of respiration and heartbeat. In addition, stage 1 sleep involves a marked decrease in both overall muscle tension and core body temperature.

As we move into stage 2 sleep, the body goes into a state of deep relaxation. Theta waves still dominate the activity of the brain, but they are interrupted by brief bursts of activity known as sleep spindles ([link]). A sleep spindle is a rapid burst of higher frequency brain waves that may be important for learning and memory (Fogel & Smith, 2011; Poe, Walsh, & Bjorness, 2010). In addition, the appearance of K-complexes is often associated with stage 2 sleep. A K-complex is a very high amplitude pattern of brain activity that may in some cases occur in response to environmental stimuli. Thus, K-complexes might serve as a bridge to higher levels of arousal in response to what is going on in our environments (Halász, 1993; Steriade & Amzica, 1998).

In terms of brain wave activity, stage 1 sleep is associated with both alpha and theta waves. The early portion of stage 1 sleep produces alpha waves, which are relatively low frequency (8–13Hz), high amplitude patterns of electrical activity (waves) that become synchronized ([link]). This pattern of brain wave activity resembles that of someone who is very relaxed, yet awake. As an individual continues through stage 1 sleep, there is an increase in theta wave activity. Theta waves are even lower frequency (4–7 Hz), higher amplitude brain waves than alpha waves. It is relatively easy to wake someone from stage 1 sleep; in fact, people often report that they have not been asleep if they are awoken during stage 1 sleep.

Stage 3 and stage 4 of sleep are often referred to as deep sleep or slow-wave sleep because these stages are characterized by low frequency (up to 4 Hz), high amplitude delta waves ([link]). During this time, an individual’s heart rate and respiration slow dramatically. It is much more difficult to awaken someone from sleep during stage 3 and stage 4 than during earlier stages. Interestingly, individuals who have increased levels of alpha brain wave activity (more often associated with wakefulness and transition into stage 1 sleep) during stage 3

and stage 4 often report that they do not feel refreshed upon waking, regardless of how long they slept (Stone, Taylor, McCrae, Kalsekar, & Lichstein, 2008).

refered from https://courses.lumenlearning.com/wsu-sandbox/chapter/stages-of-sleep/

bands:

delta: 1-4 kHz

theta: 4-7 kHz

alpha: 7-13 kHz

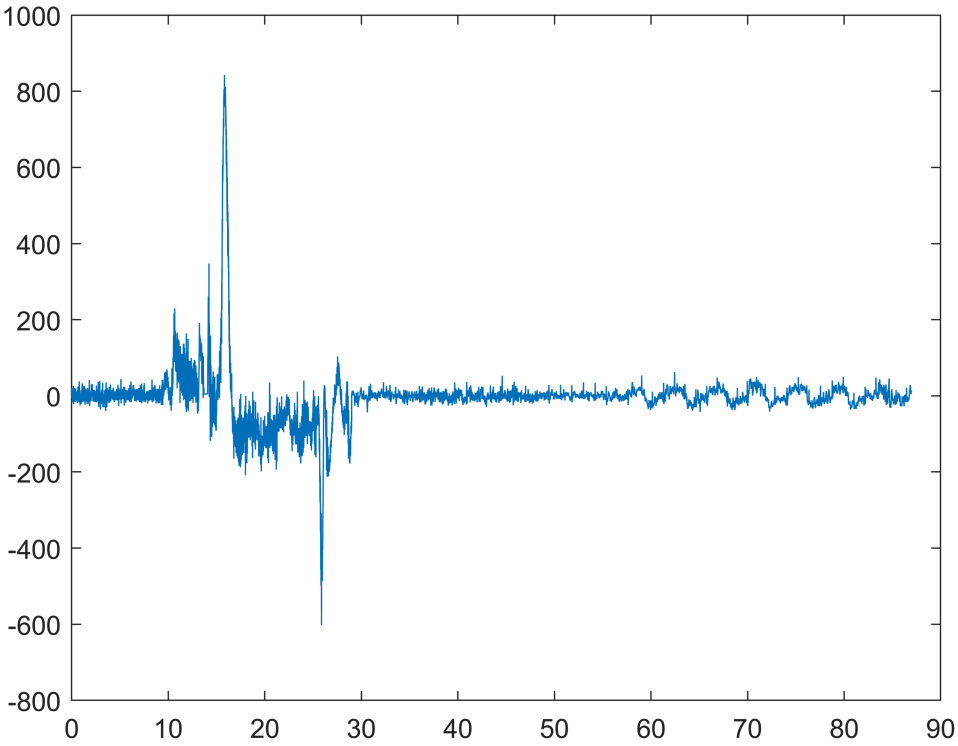
beta: 15-30 kHz

gamma: 30-80 kHz

part2:

pls load the data first

```
s0=stage0.Data((1:5800),6);
s1=stage1.Data((1:5800),6);
s2=stage2.Data((1:5800),6);
s3=to_find.Data((1:5800),6);
s4=to_find2.Data((1:5800),6);
fs=200;
ts=1/fs;
t=0:ts:ts*5800-ts;
t0=0:ts:5800*3*ts-ts;
plot(t0,cat(1,s0,s1,s2));
```

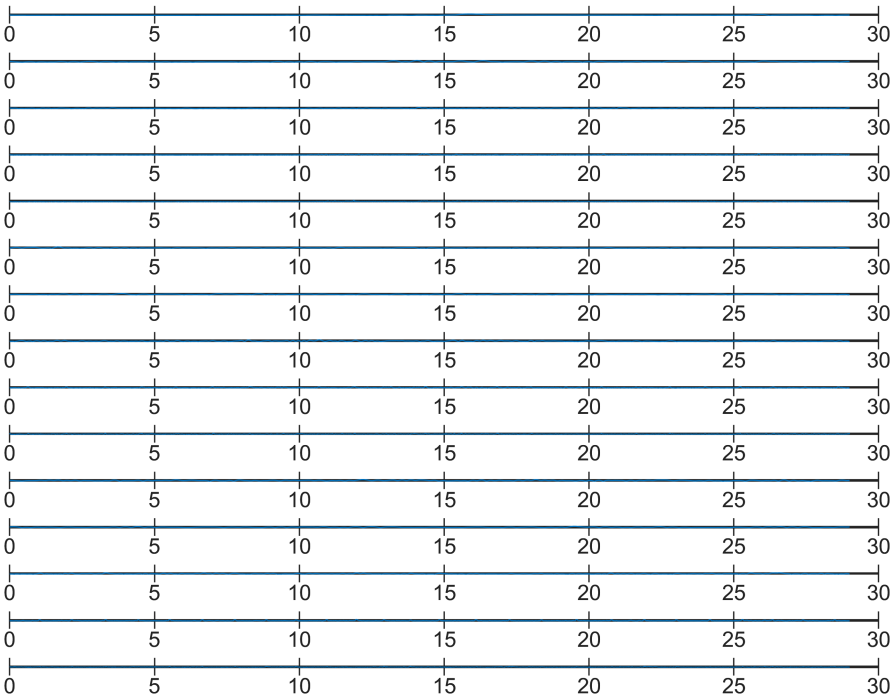


part 3:

```
y0=fft(s0);
df = fs/5800;
freq = 0:df:fs-df;

subplot(15,1,1,'replace');
h0=zeros(5800,1);
h0(1:5800/fs*4)=y0(1:5800/fs*4);
o0=ifft(h0);
plot(t,abs(o0));

subplot(15,1,2,'replace');
h0=zeros(5800,1);
h0(5800/fs*4:5800/fs*7)=y0(5800/fs*4:5800/fs*7);
o0=ifft(h0);
plot(t,abs(o0));

subplot(15,1,3,'replace');
h0=zeros(5800,1);
h0(5800/fs*7:5800/fs*13)=y0(5800/fs*7:5800/fs*13);
o0=ifft(h0);
plot(t,abs(o0));
```

```
subplot(15,1,4,'replace');
h0=zeros(5800,1);
h0(5800/fs*15:5800/fs*30)=y0(5800/fs*15:5800/fs*30);
o0=ifft(h0);
plot(t,abs(o0));

subplot(15,1,5,'replace');
h0=zeros(5800,1);
h0(5800/fs*30:5800/fs*80)=y0(5800/fs*30:5800/fs*80);
o0=ifft(h0);
plot(t,abs(o0));

y1=fft(s1);

subplot(15,1,6,'replace');
h0=zeros(5800,1);
h0(1:5800/fs*4)=y1(1:5800/fs*4);
o0=ifft(h0);
plot(t,abs(o0));

subplot(15,1,7,'replace');
h0=zeros(5800,1);
h0(5800/fs*4:5800/fs*7)=y1(5800/fs*4:5800/fs*7);
o0=ifft(h0);
plot(t,abs(o0));

subplot(15,1,8,'replace');
h0=zeros(5800,1);
h0(5800/fs*7:5800/fs*13)=y1(5800/fs*7:5800/fs*13);
o0=ifft(h0);
plot(t,abs(o0));

subplot(15,1,9,'replace');
h0=zeros(5800,1);
h0(5800/fs*15:5800/fs*30)=y1(5800/fs*15:5800/fs*30);
o0=ifft(h0);
plot(t,abs(o0));

subplot(15,1,10,'replace');
h0=zeros(5800,1);
h0(5800/fs*30:5800/fs*80)=y1(5800/fs*30:5800/fs*80);
o0=ifft(h0);
plot(t,abs(o0));

y2=fft(s2);

subplot(15,1,11,'replace');
h0=zeros(5800,1);
h0(1:5800/fs*4)=y2(1:5800/fs*4);
o0=ifft(h0);
plot(t,abs(o0));

subplot(15,1,12,'replace');
h0=zeros(5800,1);
```

```
h0(5800/fs*4:5800/fs*7)=y2(5800/fs*4:5800/fs*7);
o0=ifft(h0);
plot(t,abs(o0));

subplot(15,1,13,'replace');
h0=zeros(5800,1);
h0(5800/fs*7:5800/fs*13)=y2(5800/fs*7:5800/fs*13);
o0=ifft(h0);
plot(t,abs(o0));

subplot(15,1,14,'replace');
h0=zeros(5800,1);
h0(5800/fs*15:5800/fs*30)=y2(5800/fs*15:5800/fs*30);
o0=ifft(h0);
plot(t,abs(o0));

subplot(15,1,15,'replace');
h0=zeros(5800,1);
h0(5800/fs*30:5800/fs*80)=y2(5800/fs*30:5800/fs*80);
o0=ifft(h0);
plot(t,abs(o0));
```

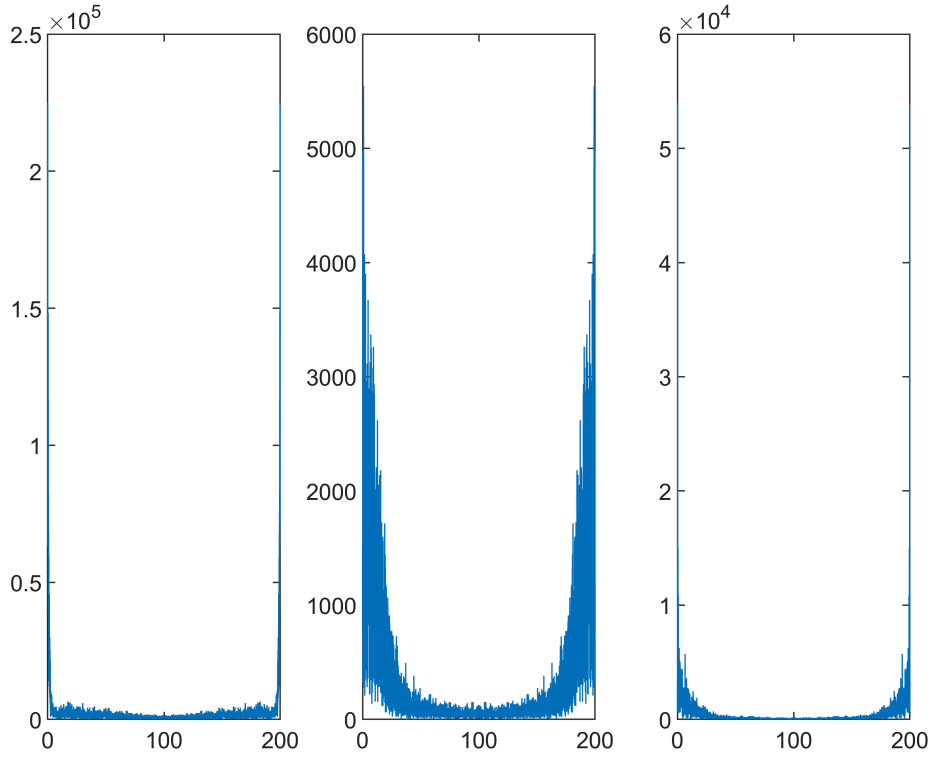


pls zoom to see plots in matlab

part 4:

```
subplot(1,3,1,"replace");
plot(freq,abs(y0));
subplot(1,3,2,"replace");
```

```
plot(freq,abs(y1));
subplot(1,3,3,"replace");
plot(freq,abs(y2));
```



we can see that the amplitude of different frequencies differs in stages

also, the order of amplitudes are also different.

part 5:

for fft plots:

stage 0: lower amps in most range

stage 1: higher amps in most freqs

stage 2: something between s0 and s1, also the shape is different

for freq bands:

stage 0: high amp in delta band and gamma band

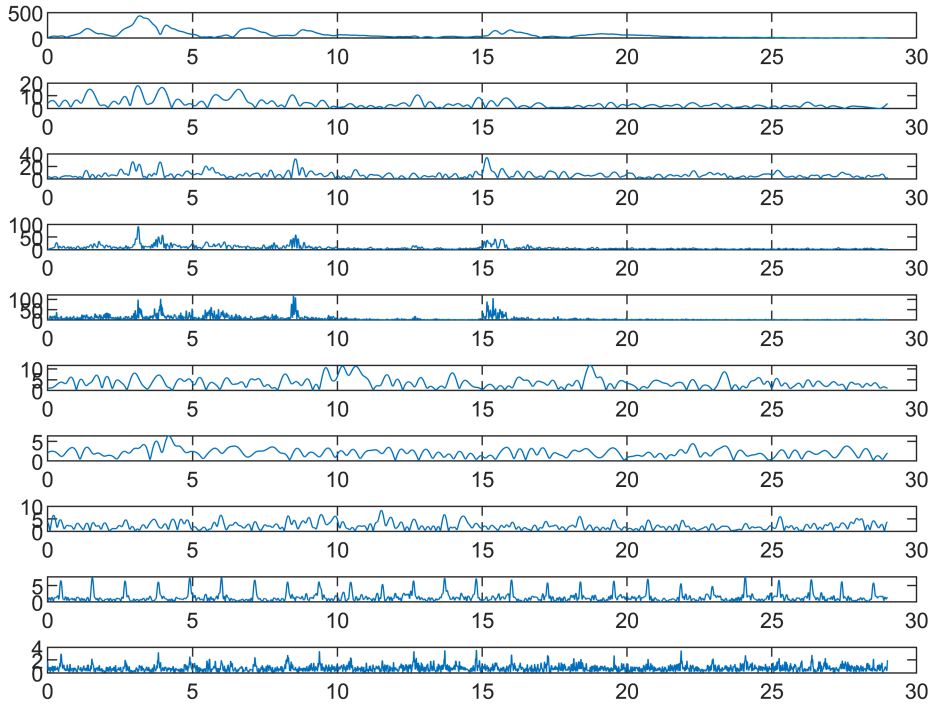
stage 1:low amp in beta band

stage 2:in contrast to stage 1, higher amp in gamma band and beta amp

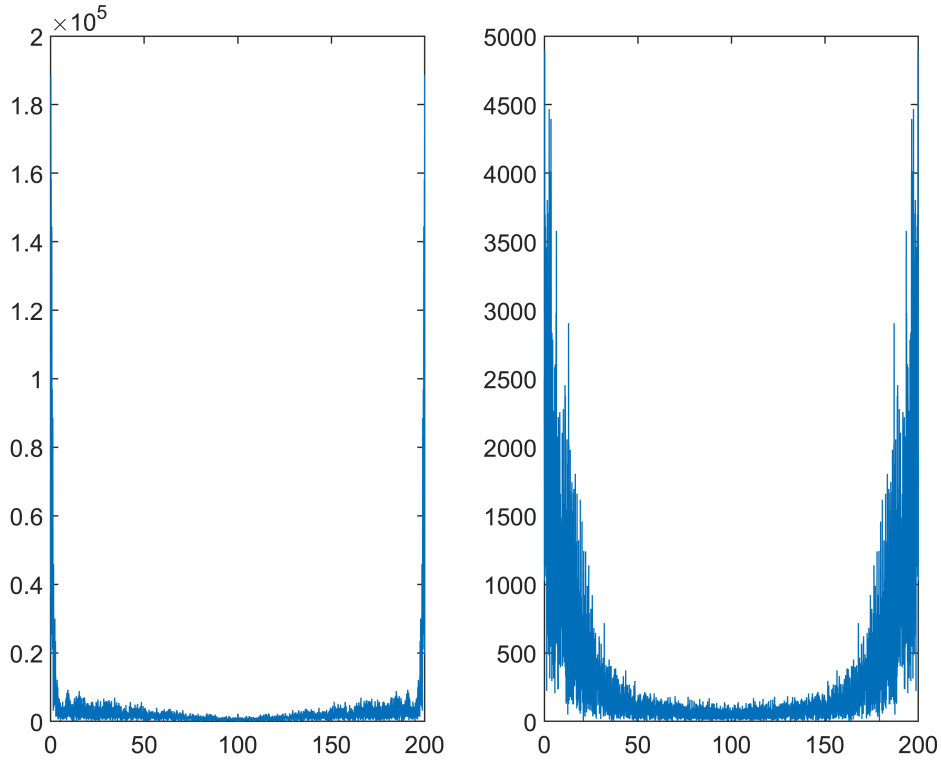
part 6:

```
y3=fft(s3);
subplot(10,1,1,'replace');
h0=zeros(5800,1);
h0(1:5800/fs*4)=y3(1:5800/fs*4);
o0=ifft(h0);
plot(t,abs(o0));

subplot(10,1,2,'replace');
h0=zeros(5800,1);
h0(5800/fs*4:5800/fs*7)=y3(5800/fs*4:5800/fs*7);
o0=ifft(h0);
plot(t,abs(o0));

subplot(10,1,3,'replace');
h0=zeros(5800,1);
h0(5800/fs*7:5800/fs*13)=y3(5800/fs*7:5800/fs*13);
o0=ifft(h0);
plot(t,abs(o0));

subplot(10,1,4,'replace');
h0=zeros(5800,1);
h0(5800/fs*15:5800/fs*30)=y3(5800/fs*15:5800/fs*30);
o0=ifft(h0);
plot(t,abs(o0));

subplot(10,1,5,'replace');
h0=zeros(5800,1);
h0(5800/fs*30:5800/fs*80)=y3(5800/fs*30:5800/fs*80);
o0=ifft(h0);
plot(t,abs(o0));

y4=fft(s4);

subplot(10,1,6,'replace');
h0=zeros(5800,1);
h0(1:5800/fs*4)=y4(1:5800/fs*4);
o0=ifft(h0);
plot(t,abs(o0));

subplot(10,1,7,'replace');
h0=zeros(5800,1);
h0(5800/fs*4:5800/fs*7)=y4(5800/fs*4:5800/fs*7);
o0=ifft(h0);
plot(t,abs(o0));

subplot(10,1,8,'replace');
h0=zeros(5800,1);
h0(5800/fs*7:5800/fs*13)=y4(5800/fs*7:5800/fs*13);
o0=ifft(h0);
plot(t,abs(o0));

subplot(10,1,9,'replace');
```

```
h0=zeros(5800,1);
h0(5800/fs*15:5800/fs*30)=y4(5800/fs*15:5800/fs*30);
o0=ifft(h0);
plot(t,abs(o0));

subplot(10,1,10,'replace');
h0=zeros(5800,1);
h0(5800/fs*30:5800/fs*80)=y4(5800/fs*30:5800/fs*80);
o0=ifft(h0);
plot(t,abs(o0));
```



```
subplot(1,2,1,"replace");
plot(freq,abs(y3));
subplot(1,2,2,"replace");
plot(freq,abs(y4));
```



judging from amplitude of bands and the shape and amplitude of fft plots, we can say data to_find1 is a stage zero and

to_find2 is a stage one.

i guess we could distinguish them by calculating power but in order to increase accuracy, i used all the tools.

in the end, i want to apoplogize for my english, i wrote this in a kind of hurry.

thank you