

Homework 3 (Due: 5/7th)

- (1) Write a Matlab or Python program that can convert a numbered musical notation (簡譜) into a music file (*.wav).

Example: (Twinkle twinkle little stars)

```
score = [1, 1, 5, 5, 6, 6, 5];    % 1: Do, 2: Re, 3: Mi, .....
```

```
beat=[ 1, 1, 1, 1, 1, 1, 2];    % 拍子
```

```
name= 'twinkle';
```

```
getmusic(score, beat, name)    % generate the music file twinkle.wav
```

The Matlab / Python code should be handed out by [NTUCool](#).

With basic requirement (score, beat, name): 24 scores

程式的功能越多，考慮的因素越多，分數越高

程式的功能要清楚說明以方便助教批改

(30 scores)

- (2) (a) Determine $2^{700} \bmod 67$.

(b) Find an integer x between 0 and 2800 that satisfies (i) $x \bmod 43 = 4$ and (ii) $x \bmod 67 = 15$ (Hint: Using the Chinese remainder theorem).

(c) Determine $39! \bmod 43$ (Hint: Using the Wilson theorem). (12 scores)

- (3) Given $M = 11$, $\alpha = 8+6i$, and $N = 12$. Determine the complex number theoretic transform (CNT) of \mathbf{x} where

$$\mathbf{x} = [0 \ 1 \ 0 \ 0 \ 0 \ 1 \ 0 \ 1 \ 0 \ 0 \ 0 \ 1]^T$$

Hint: $\text{fft}(\mathbf{x})$ is as follows. It is Ramanujan's sum.

$$\text{fft}(\mathbf{x}) = [4 \ 0 \ 2 \ 0 \ -2 \ 0 \ -4 \ 0 \ -2 \ 0 \ 2 \ 0]^T \quad (8 \text{ scores})$$

- (4) What is the Legendre sequence corresponding to $p = 11$? (Hint: The sequence should have 11 entries). (10 scores)

- (5) Suppose that there is a multipath system $y[n] = x[n] + 0.4x[n-20] + 0.2x[n-30]$.

- (a) Find $p[n]$ such that $y[n] = x[n] * p[n]$. (b) Design the lifter to remove the effect of $p[n]$ and try to not destroy $x[n]$ as possible. (10 scores)

(6) (a) Is it possible for humans to hear the voice with the frequency of 19Hz?

Why?

(b) In the noiseless case, in what condition we cannot use the variation of amplitude to separate a speech signal into several syllables?

(c) Why a music signal always has the chord (和弦) phenomenon? (15 scores)

(7) (a) What is the way to measure the uniformity (一致性) in mathematics?

(b) Why the compression ratio of an image can be higher than that of the vocal signal?

(c) In addition to the DCT, which is adopted by MP3, write at least three possible ways that can compress a music signal more efficiently. (15 scores)

(Extra): Answer the questions according to your student ID number.

(ended with 0, 1, 3, 4, 5, 6, 8, 9)