HW 1   Basic Concepts of DSP

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1. Please plot the first 2, 3, 4, and 5 terms of the following signal by Matlab (for-loop). W_1 is freely assigned.

$$y(t)=\frac{4}{\pi}(\sin(w_1t)+\frac{1}{3}\sin(3w_1t)+\frac{1}{5}\sin(5w_1t)+\frac{1}{7}\sin(7w_1t)+\frac{1}{9}\sin(9w_1t)+\cdots)$$

2. The Complex Fourier Series formula is shown below.

$$x(t)=\sum_{k=-\infty}^{\infty}a_ke^{jk\omega_0t} \qquad a_k=\frac{1}{T_0}\int_{T_0}x(t)e^{-jk\,w_0t}\,dt$$

(a) If $x(t)=\sum_{k=-2}^{+2}a_ke^{jk2\pi t}$ with $a_0=1$, $a_1=a_{-1}=\frac{1}{4}$, $a_2=a_{-2}=\frac{1}{2}$,

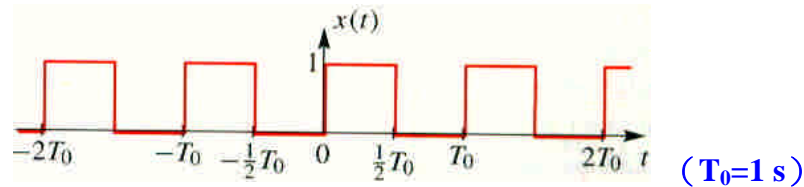Please express x(t) in terms of sinusoids ' sin ' or 'cos'.

(b) For the periodic square wave, which is defined for one cycle by

$$x(t)=\begin{cases}1 & for\ \ 0\le t<\dfrac{T_0}{2}\\[2mm]0 & for\ \ \dfrac{T_0}{2}\le t\le T_0\end{cases}\ \text{, where }\ T_0=\frac{2\pi}{w_0}$$

please draw the waveform of x(t) and evaluate Fourier coefficient a_0

(c) What is the physical meaning of Fourier coefficient a_0?

3. For the following signal,

（T_0=1 s）

please verify that its Fourier coefficients $a_k=\begin{cases}\dfrac{1}{j\pi k} & k=\pm1,\pm3,\pm5,\cdots\\[2mm]0 & k=\pm2,\pm4,\pm6,\cdots\\[2mm]\dfrac{1}{2} & k=0\end{cases}$ and plot

$|a_k|$ (k= -13~13) by Matlab.

4. Please write a Matlab program (for-loop) to simulate the tone, lasting about 0.5 sec, of each key in the piano.